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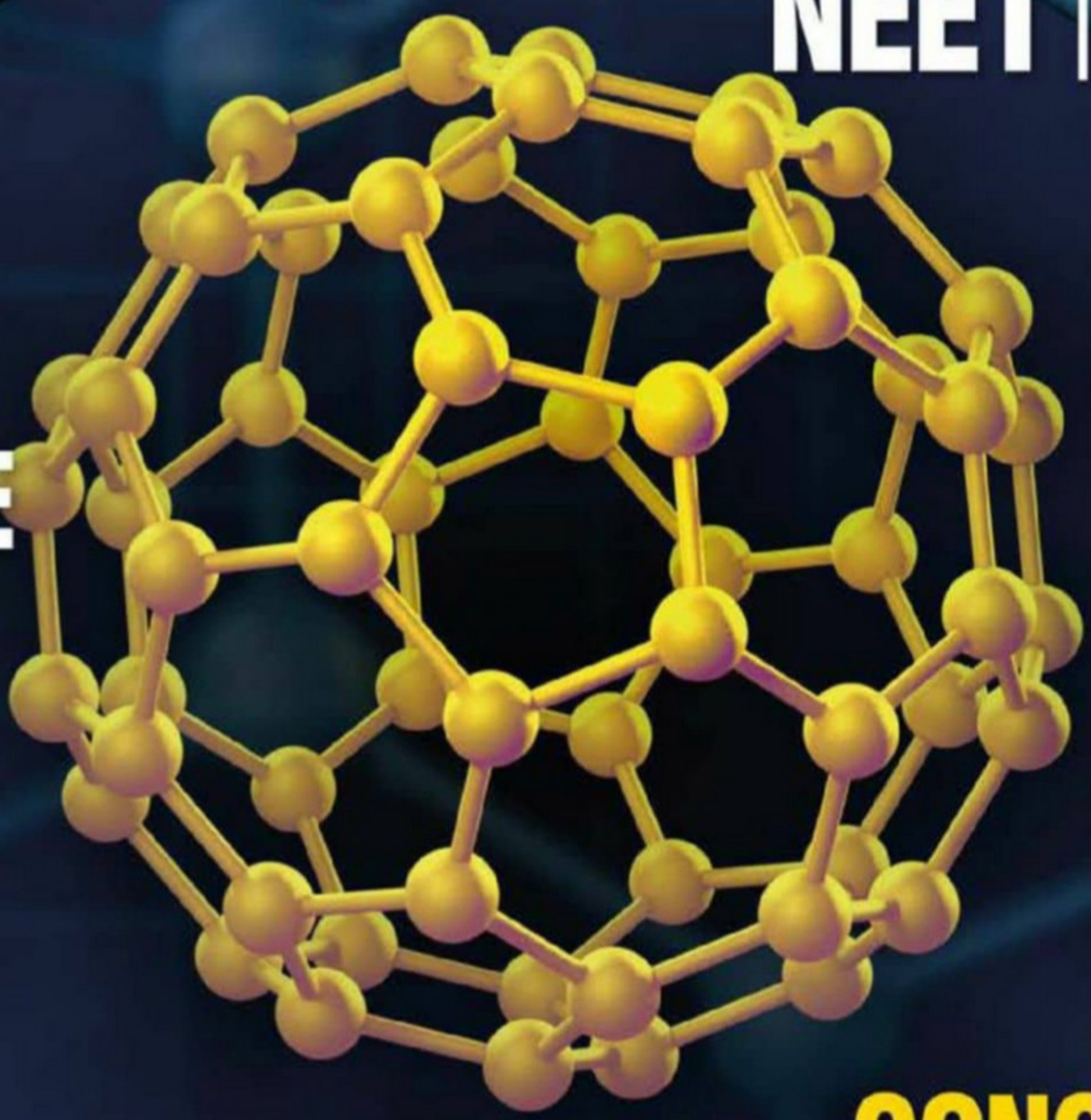

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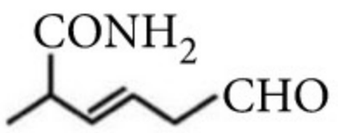
Editor : Anil Ahlawat

PRACTICE PAPER

NEET

Exam on
13th September 2020

1. The IUPAC name of the compound



is

(a) 5-carbamoylhex-1-enal
(b) 2-carbamoylhex-3-enal
(c) 2-methyl-6-oxohex-3-enamide
(d) 6-keto-2-methylhexanamide.

2. The following two reactions of HNO_3 with Zn are given as :

$Zn + \text{conc. } HNO_3 \longrightarrow Zn(NO_3)_2 + X + H_2O$

$Zn + \text{dil. } HNO_3 \longrightarrow Zn(NO_3)_2 + Y + H_2O$

The compounds X and Y respectively are

(a) NO_2 and NO (b) NO_2 and NO_2
(c) NO and NO_2 (d) NO_2 and NH_4NO_3

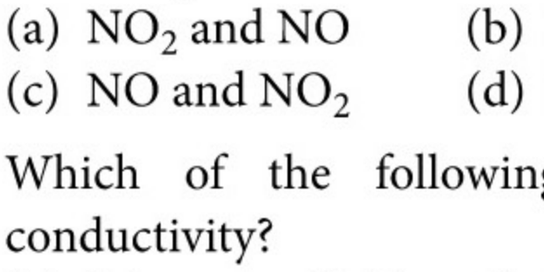
3. Which of the following has highest molar conductivity?

(a) Diamminedichloroplatinum(II)
(b) Tetraamminedichlorocobalt(III) chloride
(c) Potassium hexacyanoferrate(II)
(d) Pentacarbonyliron(0)

4. Sanger's reagent is used for the identification of

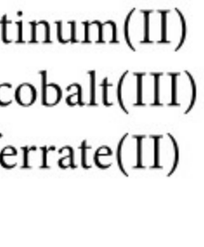
(a) N-terminal of a peptide chain
(b) C-terminal of a peptide chain
(c) side chain of amino acids
(d) molecular mass of the peptide chain.

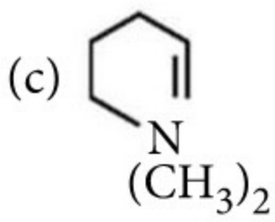
5. In the following reaction,

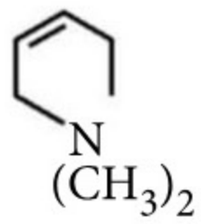


The organic product X is

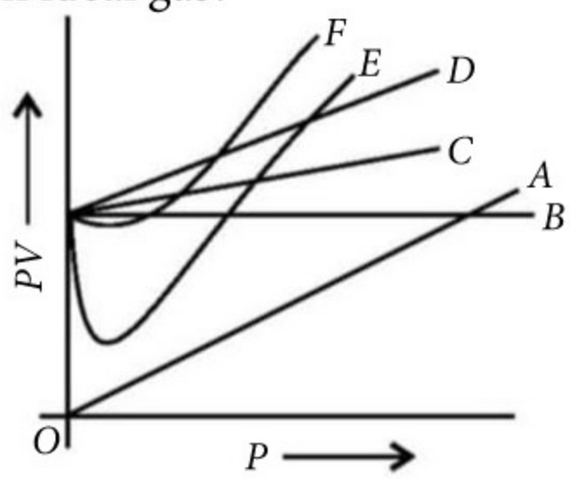
(a) 

(b) 

(c) 

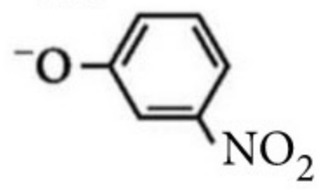
(d) 

6. Which of the following curves represents the curve of an ideal gas?



(a) B only (b) C and D only
(c) E and F only (d) A and B only

7. Which of the following species is the strongest base?

(a) ^-OH (b) ^-OR
(c) $^-OC_6H_5$ (d) 

8. We have three aqueous solutions of NaCl labelled as 'A', 'B' and 'C' with concentrations 0.1 M, 0.01 M and 0.001 M, respectively. The value of van't Hoff factor for these solutions will be in the order

(a) $i_A < i_B < i_C$ (b) $i_A > i_B > i_C$
(c) $i_A = i_B = i_C$ (d) $i_A < i_B > i_C$

9. For the reaction,

$$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)}$$

$B.E._{(H-H)} = x_1$; $B.E._{(O=O)} = x_2$ and $B.E._{(O-H)} = x_3$. If the latent heat of vaporisation of water liquid into water vapour = x_4, then $\Delta_f H$ (heat of formation of liquid water) is

(a) $x_1 + \frac{x_2}{2} - x_3 + x_4$

(b) $2x_3 - x_1 - \frac{x_2}{2} - x_4$

(c) $x_1 + \frac{x_2}{2} - 2x_3 - x_4$

(d) $x_1 + \frac{x_2}{2} - 2x_3 + x_4$

10. In the given reactions sequence,

$$MSO_4 \xrightarrow{NH_4OH} \underset{\text{White}}{X\downarrow} \xrightarrow[\text{Excess}]{NH_4OH} Y \xrightarrow{H_2S} Z\downarrow$$

M and Z are respectively

(a) Zn, ZnS (b) Al, Al_2S_3

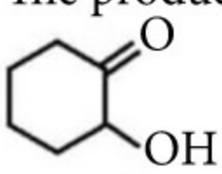
(c) Cu, ZnS (d) Fe, FeS

11. If the equilibrium constant of $BOH \rightleftharpoons B^+ + OH^-$ at 25°C is 2.5×10^{-6}, then equilibrium constant for $BOH + H^+ \rightleftharpoons B^+ + H_2O$ at the same temperature is

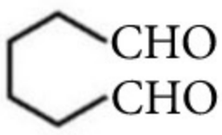
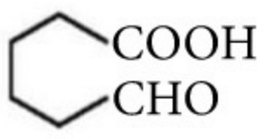
(a) 4.0×10^{-9} (b) 4.0×10^{5}

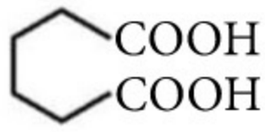
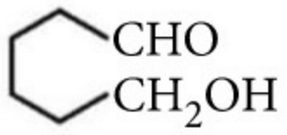
(c) 2.5×10^{8} (d) 2.5×10^{-6}

12. The product obtained when,



is oxidised with HIO_4 is

(a)  (b) 

(c)  (d) 

13. Which is finally produced when acetylene reacts with HCl?

(a) $CH_2{=}CHCl$ (b) CH_3CHCl_2

(c) $ClCH{=}CHCl$ (d) None of these

14. An unknown element forms an oxide. What will be the equivalent weight of the element if the oxygen content is 20% by weight?

(a) 16 g (b) 32 g

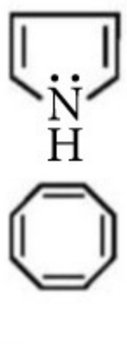
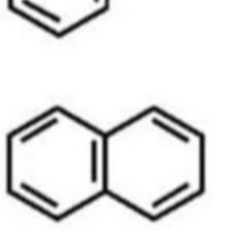
(c) 8 g (d) 64 g

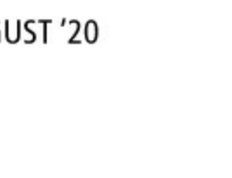
15. The ligand called π-acid is

(a) CO (b) NH_3

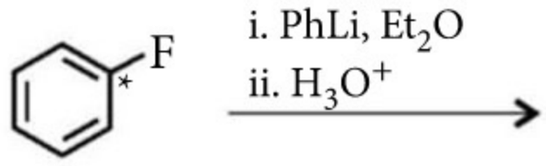
(c) $C_2O_4^{2-}$ (d) ethylenediamine.

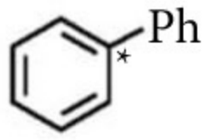
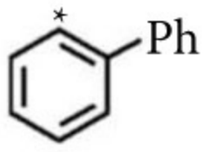
16. Which of the following is an anti-aromatic compound?

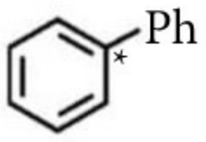
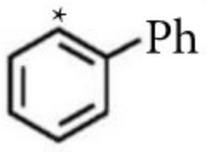
(a)  (b) 

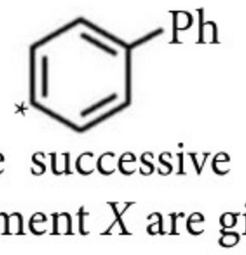
(c)  (d) 

17. Identify the product of the following reaction.



(a)  (b) 

(c)  + 

(d) 

18. The successive ionisation enthalpy values for an element X are given as :

1^{st} ionisation enthalpy = 410 kJ mol^{-1}

2^{nd} ionisation enthalpy = 820 kJ mol^{-1}

3^{rd} ionisation enthalpy = 1100 kJ mol^{-1}

4^{th} ionisation enthalpy = 1500 kJ mol^{-1}

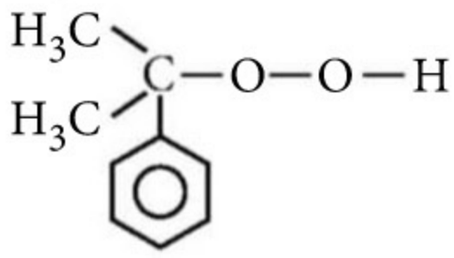
5^{th} ionisation enthalpy = 3200 kJ mol^{-1}

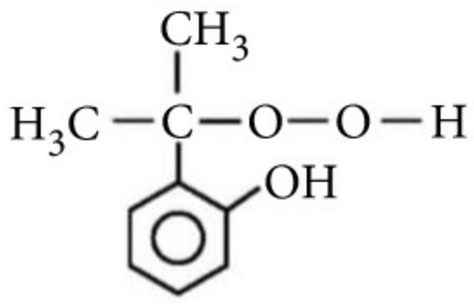
Find out the number of valence electrons for the atom X.

(a) 4 (b) 3 (c) 5 (d) 2

19. Phenol is distilled with Zn dust followed by Friedel–Crafts alkylation with propyl chloride in the presence of $AlCl_3$ to give a compound B. B is oxidised in the presence of air to form the compound C. The structural formula of C is

(a)

(b) 

(c) 

(d) 

20. $\Lambda^\circ_{m(NH_4OH)}$ is equal to

(a) $\Lambda^\circ_{m(NH_4OH)} + \Lambda^\circ_{m(NH_4Cl)} - \Lambda^\circ_{m(HCl)}$

(b) $\Lambda^\circ_{m(NH_4Cl)} + \Lambda^\circ_{m(NaOH)} - \Lambda^\circ_{m(NaCl)}$

(c) $\Lambda^\circ_{m(NH_4Cl)} + \Lambda^\circ_{m(NaCl)} - \Lambda^\circ_{m(NaOH)}$

(d) $\Lambda^\circ_{m(NaOH)} + \Lambda^\circ_{m(NaCl)} - \Lambda^\circ_{m(NH_4Cl)}$

21. At the equilibrium position in the process of adsorption

(a) $\Delta H > 0$ (b) $\Delta H = T\Delta S$

(c) $\Delta H > T\Delta S$ (d) $\Delta H < T\Delta S$

22. Distinction between primary, secondary and tertiary alcohols is done by

(a) oxidation method

(b) Lucas test

(c) Victor Meyer method

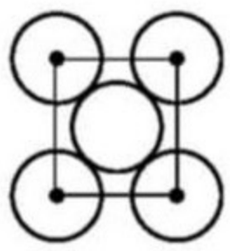
(d) all of these.

23. The frequency of radiation emitted when the electron falls from $n = 4$ to $n = 1$ in a hydrogen atom will be

(a) $3.08 \times 10^{15}\ s^{-1}$ (b) $2.00 \times 10^{15}\ s^{-1}$

(c) $1.54 \times 10^{15}\ s^{-1}$ (d) $1.03 \times 10^{15}\ s^{-1}$

24. The packing efficiency of the two dimensional square unit cell shown is



(a) 39.27% (b) 68.02%

(c) 74.05% (d) 78.54%

25. In Ramsay and Rayleigh's isolation of noble gases from air, the nitrogen of the air is finally converted into

(a) $NaNO_2$ only (b) NO and NO_2

(c) $NaNO_3$ only (d) $NaNO_2$ and $NaNO_3$

26. The gold number of some colloidal solutions are given as :

Colloidal solution	Gold number
A	0.01
B	2.5
C	20

The protective nature of these colloidal solutions follows the order

(a) $C > B > A$ (b) $A > B > C$

(c) $A = B = C$ (d) $B > A > C$

27. $CH_3CH_2NH_2$ contains a basic NH_2 group, but CH_3CONH_2 does not

(a) acetamide is amphoteric in character

(b) in ethyl amine the electron pair on N-atom is delocalised by resonance

(c) in ethyl amine there is no resonance while in acetamide the lone pair of electrons on N-atom is delocalised and is less available for protonation

(d) all of these.

28. Match the options given in column I with column II.

	Column I		Column II
P.	Mathematical expression for rate of reaction	1.	rate constant
Q.	Rate of reaction for zero order reaction is equal to	2.	rate law
R.	Units of rate constant for zero order reaction is same as that of	3.	order of slowest step
S.	Order of a complex reaction is determined by	4.	rate of the reaction

	P	Q	R	S
(a)	1	2	4	3
(b)	3	4	1	2
(c)	2	1	4	3
(d)	2	1	3	4

29. The thermal stability of the hydrides of O, S, Se and Te varies in the order

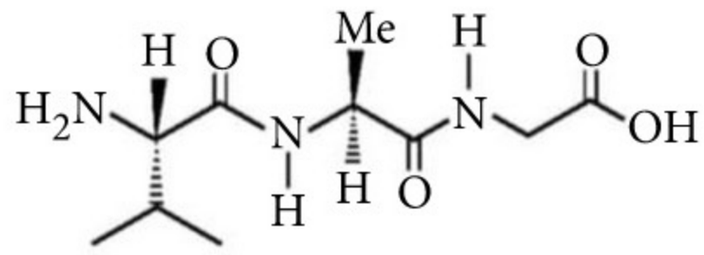
(a) $H_2Te > H_2Se > H_2S > H_2O$

(b) $H_2O > H_2S > H_2Se > H_2Te$

(c) $H_2O > H_2Se > H_2Te > H_2S$

(d) $H_2S > H_2O > H_2Se > H_2Te$

30. Which of the following amino acids can be used to synthesise the given tripeptide ?



(a) Glycine, leucine and alanine

(b) Alanine, isoleucine and glycine

(c) Valine, alanine and glycine

(d) Alanine, serine and glycine

31. In the anion $HCOO^-$ the two carbon-oxygen bonds are found to be of equal length because

(a) the C═O bond is weaker than the C—O bond

(b) the anion $HCOO^-$ shows resonance

(c) the anion is obtained by removal of a proton from the acid molecule

(d) the electronic orbitals of carbon atom are hybridised.

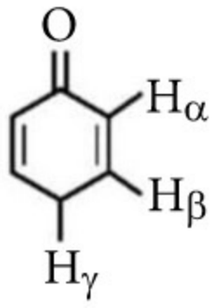
32. In chromic acid anhydride (CrO_3), Cr has d^0 configuration but it is bright orange coloured solid, the colour is due to

(a) *d-d* transition
(b) charge transfer ($L \rightarrow M$) transition
(c) charge transfer ($M \rightarrow L$) transition
(d) *p-d* transition.

33. A cylinder filled with a movable piston contains liquid water in equilibrium with water vapours at 25°C. Which one of the following operations results in a decrease in the equilibrium vapour pressure?
(a) Moving the piston downward a short distance
(b) Removing a small amount of vapour
(c) Removing a small amount of the liquid water
(d) Dissolving salt in the water

34. The carbohydrate that yields glucose and galactose on acid hydrolysis is
(a) sucrose (b) lactose
(c) maltose (d) starch.

35. During enolisation of the following compound, which of the labelled hydrogen is involved?



(a) H_α (b) H_β
(c) H_γ (d) Any of the three

36. The correct order of the ligands, OH^-, NO_3^-, PPh_3, pyridine, according to their increasing field strength is
(a) $NO_3^- < OH^- <$ pyridine $< PPh_3$
(b) $OH^- < NO_3^- < PPh_3 <$ pyridine
(c) $OH^- < NO_3^- <$ pyridine $< PPh_3$
(d) $NO_3^- < OH^- < PPh_3 <$ pyridine

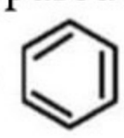
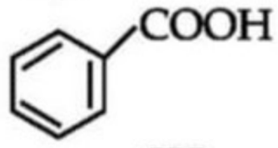
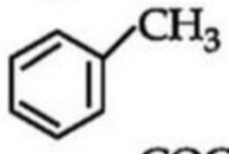
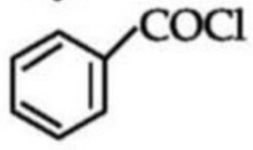
37. A scarlet compound (*A*) Pb_3O_4 gives a chocolate brown ppt. (*B*) and a colourless solution (*C*) with HNO_3. The brown ppt. (*B*) is of
(a) PbO_2 (b) $2Pb(NO_3)_2$
(c) PbO (d) none of these.

38. Consider the following sets of quantum numbers :

	n	*l*	*m*	*s*
(i)	3	0	0	+1/2
(ii)	2	2	1	+1/2
(iii)	4	3	–2	–1/2
(iv)	1	0	–1	–1/2
(v)	3	2	3	+1/2

Which of the following sets of quantum number is not possible?
(a) (i), (ii), (iii) and (iv)
(b) (ii), (iv) and (v)
(c) (i) and (iii)
(d) (ii), (iii) and (iv)

39. When excess of KI is added to aqueous $CuSO_4$, the solution acquires dark brown colouration. This is due to the formation of
(a) $CuI_{2(s)}$ (b) $Cu_2I_{2(s)}$
(c) $I^-_{3(aq)}$ (d) $I_{2(s)}$

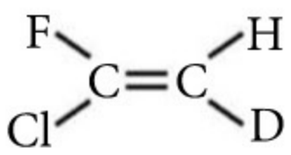
40. Reaction by which benzaldehyde cannot be prepared is
(a)  + CO + HCl in presence of anhydrous $AlCl_3$
(b)  + Zn/Hg and conc. HCl
(c)  + CrO_2Cl_2 in CS_2 followed by H_3O^+
(d)  + H_2 in presence of Pd-$BaSO_4$

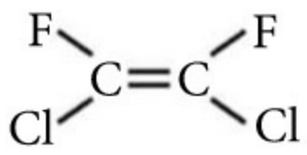
41. Hydrazine reacts with KIO_3 in presence of HCl as
$N_2H_4 + IO_3^- + 2H^+ + Cl^- \longrightarrow ICl + N_2 + 3H_2O$
The equivalent masses of N_2H_4 and KIO_3 respectively are
(a) 16 and 87 (b) 16 and 53.5
(c) 8 and 53.5 (d) 8 and 87

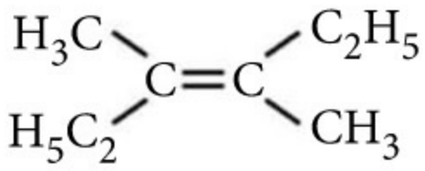
42. Match the polymers given in column I with their chemical names given in column II.

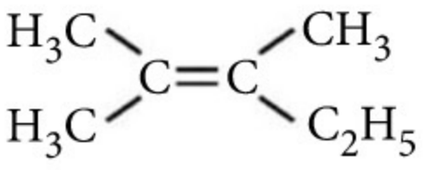
Column I	**Column II**
P. Nylon 6	1. Polyvinyl chloride
Q. PVC	2. Polyacrylonitrile
R. Acrilan	3. Polycaprolactum
S. Natural rubber	4. *cis*-Polyisoprene

	P	**Q**	**R**	**S**
(a)	1	2	3	4
(b)	4	3	1	2
(c)	3	1	4	2
(d)	3	1	2	4

43. Which of the following will not show geometrical isomerism?
(a) 

(b) 

(c) 

(d) 

44. Following data is given at 25°C,

$Ag + I^- \longrightarrow AgI + e^-$; $E° = 0.152$ V

$Ag \longrightarrow Ag^+ + e^-$; $E° = 0.800$ V

What is the value of log K_{sp} for AgI?

(a) – 37.83 (b) – 16.13

(c) – 8.12 (d) + 8.612

45. Antiseptic action of dettol is due to

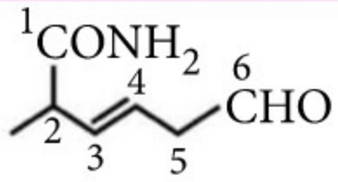
(a) 4-chloro-3, 5-dimethylphenol

(b) 3-chloro-4, 5-dimethylphenol

(c) 4-chloro-2, 5-dimethylphenol

(d) 5-chloro-3, 4-dimethylphenol.

SOLUTIONS

1. (c) : 

2-Methyl-6-oxohex-3-enamide

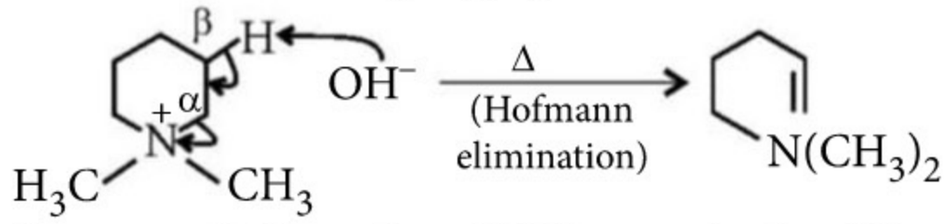
2. (d) : $Zn + 4HNO_3$ (conc.) $\longrightarrow Zn(NO_3)_2 + 2NO_2 + 2H_2O$

$4Zn + 10HNO_3$(dil.) $\longrightarrow 4Zn(NO_3)_2 + NH_4NO_3 + 3H_2O$

3. (c) : $K_4[Fe(CN)_6] \rightleftharpoons 4K^+ + [Fe(CN)_6]^{4-}$

Potassium hexacyanoferrate(II) gives a total of 5 ions in aqueous solution thus, it has the highest molar conductivity whereas other complexes will give lesser number of ions.

4. (a) : Sanger's reagent is used for the identification of N-terminal residue of a polypeptide.

5. (c) : 

6. (a) : For curve *B*, the value of *PV* is constant and for an ideal gas, plot of *PV vs P* is a straight line, parallel to *x*-axis.

7. (b) : ^-OR is the strongest base since *R* (alkyl) group is an electron releasing group which increases electron density on oxygen.

8. (c) : The value of van't Hoff factor for the given solutions will be the same, *i.e.*, $i_A = i_B = i_C$ due to complete dissociation of NaCl (strong electrolyte) in dilute solutions. On complete dissociation value of *i* for NaCl is 2.

9. (c) : $\Delta_f H = (B.E.)_{reactants} - (B.E.)_{products}$

But all the species must be in gaseous state, so in product $[H_2O_{(l)} \longrightarrow H_2O_{(g)}]$ ΔH_{vap} must be added.

Hence for the reaction, $H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)}$

$$\Delta_f H = \left[(B.E.)_{H-H} + \frac{1}{2}(B.E.)_{O=O}\right] - [\Delta H_{vap} + 2(B.E.)_{O-H}]$$

$$= x_1 + \frac{x_2}{2} - [x_4 + 2x_3] \Rightarrow x_1 + \frac{x_2}{2} - x_4 - 2x_3$$

10. (a) : $ZnSO_4 \xrightarrow{NH_4OH} \underset{(X)\ \text{(White)}}{Zn(OH)_2\downarrow} \xrightarrow[\text{Excess}]{NH_4OH}$ Clear solution $\xrightarrow{H_2S}$ $\underset{(Z)}{ZnS\downarrow}$

Thus, *M* is Zn.

11. (c) : $BOH \rightleftharpoons B^+ + \bar{O}H$; $(K_b = 2.5 \times 10^{-6})$

$H^+ + \bar{O}H \rightleftharpoons H_2O$; $\left(K = \frac{1}{K_w}\right)$

$BOH + H^+ \rightleftharpoons B^+ + H_2O$; $K' = ?$

$$\therefore \quad K' = K_b \times \frac{1}{K_w} = \frac{2.5\times10^{-6}}{10^{-14}} = 2.5 \times 10^8$$

12. (b) : 

13. (b) : $CH \equiv CH + HCl \longrightarrow CH_2 = CHCl \xrightarrow{HCl} CH_3—CHCl_2$

14. (b) : Given that oxygen content is 20% by weight, then

eq. wt. of unknown element = $\frac{80}{20} \times 8\,g = 32$ g

15. (a)

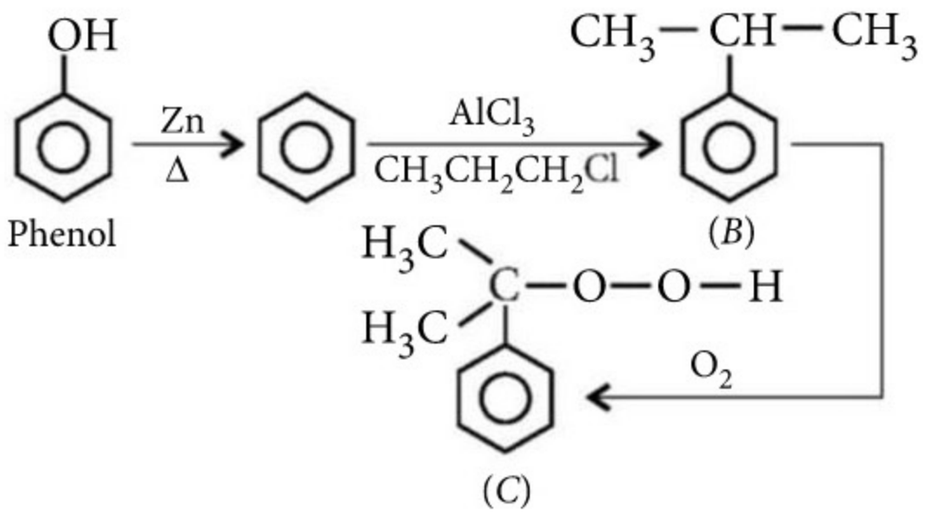
16. (c) : Planar conjugated cyclic compounds containing $4n\pi$ electrons are anti-aromatic, *e.g.*, cyclooctatetraene (8π e^-s).

17. (c) :

Biphenyl

18. (a) : Removal of 5^{th} electron requires almost more than double the energy required for removing 4^{th} electron. Therefore, the valence electrons should be 4.

19. (b):



20. (b): $NH_4Cl \rightleftharpoons NH_4^+ + Cl^-$ ...(i)

$NaCl \rightleftharpoons Na^+ + Cl^-$ ...(ii)

$NaOH \rightleftharpoons Na^+ + OH^-$ ...(iii)

$NH_4OH \rightleftharpoons NH_4^+ + OH^-$ ...(iv)

Applying (i) + (iii) – (ii) to get the equation (iv),

$$\Lambda^\circ_{m(NH_4Cl)} + \Lambda^\circ_{m(NaOH)} - \Lambda^\circ_{m(NaCl)} = \Lambda^\circ_{m(NH_4OH)}$$

21. (b): At equilibrium during adsorption, $\Delta G = 0$ and ΔH becomes equal to $T\Delta S$.

22. (d)

23. (a): $E_n = \dfrac{-2.18\times10^{-18}}{n^2}$ J atom^{-1}

$$\Delta E = E_4 - E_1 = -2.18\times10^{-18}\left(\frac{1}{4^2}-\frac{1}{1^2}\right)$$

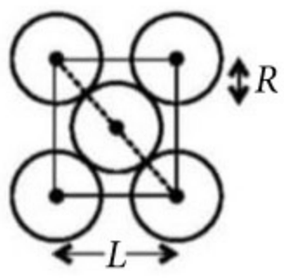
$= -2.18\times10^{-18}(-0.9375) \Rightarrow 2.043\times10^{-18}$ J atom^{-1}

Also, $\Delta E = h\upsilon$

$$\therefore \quad \upsilon = \frac{\Delta E}{h} = \frac{2.043\times10^{-18}}{6.625\times10^{-34}} = 3.08\times10^{15}\ s^{-1}$$

24. (d): $4R = L\sqrt{2}$

so, $L = 2\sqrt{2}R$



Area of square unit cell = $(2\sqrt{2}R)^2$

$= 8R^2$

Area of atoms present in one unit cell

$$= \pi R^2 + 4\left(\frac{\pi R^2}{4}\right) = 2\pi R^2$$

So, packing efficiency = $\dfrac{2\pi R^2}{8R^2}\times100 = \dfrac{\pi}{4}\times100$

$\approx 78.54\%$

25. (d): Nitrogen is finally converted into $NaNO_2$ and $NaNO_3$ in Ramsay and Rayleigh's method.

$N_2 + O_2 \longrightarrow 2NO$

$2NO + O_2 \longrightarrow 2NO_2$

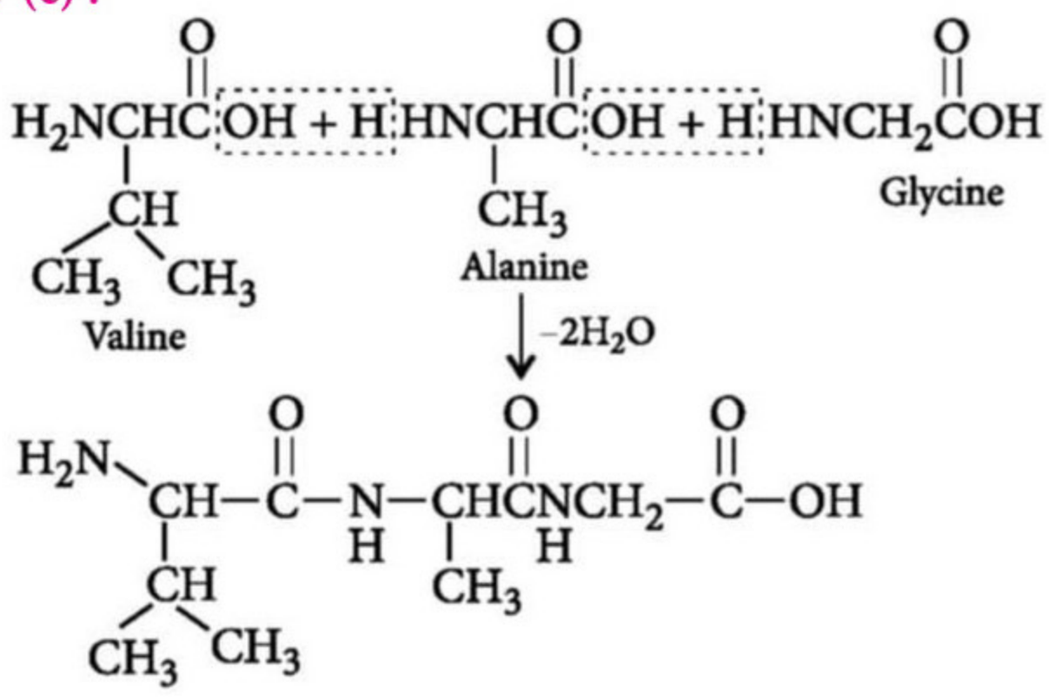
$2NO_2 + 2NaOH \longrightarrow NaNO_2 + NaNO_3 + H_2O$

26. (b): Higher the gold number, lower will be the protective power of a colloidal solution.

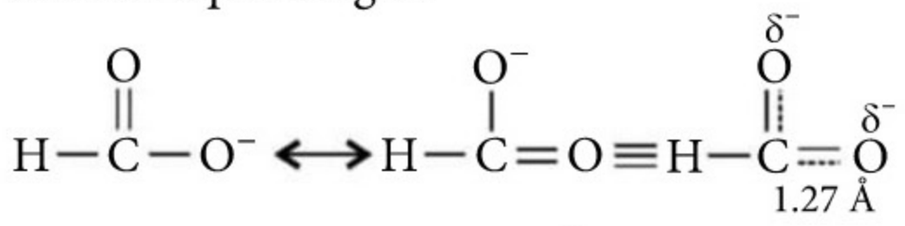
27. (c) **28. (c)**

29. (b): Thermal stability decreases as the size of atom increases (down the group). Thus, H_2O is most stable and H_2Te is least stable.

30. (c):



31. (b): As the anion $HCOO^-$ has two resonating structures, so the carbon-oxygen bonds are found to be of equal length.

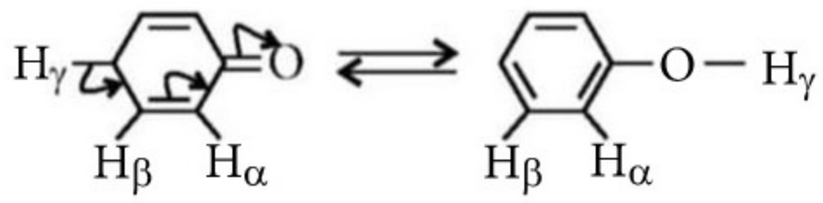


32. (b): The colour of CrO_3 (d^0 configuration) is due to charge transfer from ligand (oxygen) to metal (chromium) and not due to *d-d* transition.

33. (d): Dissolving salt in a solvent or liquid lowers the vapour pressure.

34. (b): Lactose on hydrolysis with acetic acid gives glucose and galactose.

35. (c): H_γ being located on a saturated carbon is more labile than H_α and H_β and hence, is involved in enolisation.



36. (a) : $\underset{\text{Weak field ligand}}{NO_3^-} < OH^- < py < \underset{\text{Strong field ligand}}{PPh_3}$

37. (a) : $\underset{\text{Scarlet compound } (A)}{Pb_3O_4} + 4HNO_3 \longrightarrow \underset{\text{Brown ppt. } (B)}{PbO_2\downarrow} + \underset{\text{Colourless solution } (C)}{2Pb(NO_3)_2} + 2H_2O$

38. (b) : (i) represents an electron in 3*s* orbital.
(ii) is not possible as value of *l* varies from 0 to $(n-1)$.
(iii) represents an electron in 4*f* orbital.
(iv) is not possible as value of *m* varies from $-l$ to $+l$.
(v) is not possible as value of *m* varies from $-l$ to $+l$, it can never be greater than *l*.

39. (c) : $2CuSO_4 + 4KI \longrightarrow Cu_2I_2 + 2K_2SO_4 + I_2$;
$I_{2(s)} + I^-_{(aq)} \longrightarrow \underset{\text{(dark brown)}}{I^-_{3(aq)}}$

40. (b) : Zn-Hg and conc. HCl reduces aldehydes and ketones but carboxylic acid group remains unaffected.

41. (c) : O.N. of N in N_2H_4 is -2 which changes to 0 in N_2.

Hence, eq. mass of $N_2H_4 = \frac{\text{molar mass}}{2\times2} = \frac{32}{4} = 8$

O.N. of iodine changes from +5 in IO_3^- to +1 in ICl.

Hence, eq. mass of $KIO_3 = \frac{\text{molar mass}}{4} = \frac{214}{4} = 53.5$

42. (d)

43. (d) : $\begin{matrix}H_3C\\H_3C\end{matrix}\!\!>\!C=C\!<\!\begin{matrix}CH_3\\C_2H_5\end{matrix}$ will not show geometrical isomerism due to the presence of similar alkyl groups on the same carbon atom of double bond.

44. (b) : $Ag + I^- \longrightarrow AgI + e^-,\ E_1^\circ = 0.152\ V$
$Ag^+ + e^- \longrightarrow Ag,\ E_2^\circ = 0.800\ V$
$Ag^+ + I^- \longrightarrow AgI,\ E^\circ = 0.952\ V$

At equilibrium, $E^\circ = \frac{2.303RT}{F}\log K_c$

But $K_c = \frac{[AgI]}{[Ag^+][I^-]} = \frac{1}{K_{sp}}$

$\therefore \quad 0.952 = -\frac{2.303RT}{F}\log K_{sp} = -0.059 \log K_{sp}$

or $\log K_{sp} = -16.13$

45. (a) : 4-Chloro-3,5-dimethylphenol, also called chloroxylenol has antiseptic properties.

GEAR UP FOR JEE MAIN

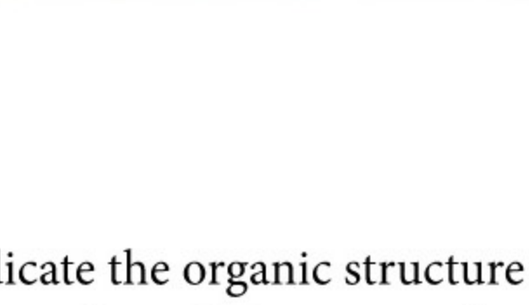
EXAM ON 1st - 6th September 2020

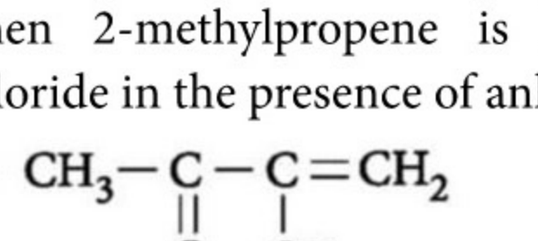
with Numerical Value Type Questions

1. Indicate the organic structure for product expected when 2-methylpropene is heated with acetyl chloride in the presence of anhydrous $ZnCl_2$.

(a)

(b) 

(c) 

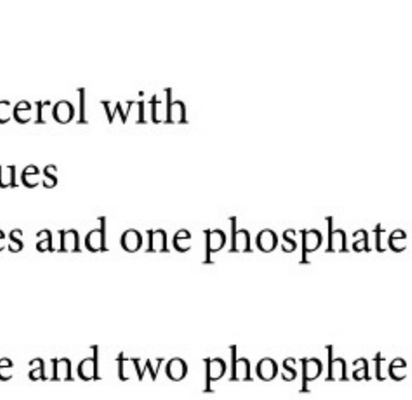
(d) 

2. Phospholipids are esters of glycerol with
(a) three carboxylic acid residues
(b) two carboxylic acid residues and one phosphate group
(c) one carboxylic acid residue and two phosphate groups
(d) three phosphate groups.

3. Which of the following alkali metal ions has the highest conductivity in aqueous solution?
(a) Li^+ (b) Cs^+ (c) Na^+ (d) K^+

4. In order to convert aniline into chlorobenzene, the reagent used is
(a) $NaNO_2/HCl$, CuCl (b) Cl_2/CCl_4
(c) $Cl_2/AlCl_3$ (d) $CuCl_2$

5. For the given structure, the site marked as *S* is a



(a) tetrahedral void
(b) cubic void
(c) octahedral void
(d) none of these.

6. Which one of the following cyano complexes would exhibit the lowest value of paramagnetic behaviour?
(a) $[Cr(CN)_6]^{3-}$ (b) $[Mn(CN)_6]^{3-}$
(c) $[Fe(CN)_6]^{3-}$ (d) $[Co(CN)_6]^{3-}$

7. If the nitrogen atom has electronic configuration $1s^7$, it would have energy lower than that of the normal ground state configuration $1s^2 2s^2 2p^3$, because the electrons would be closer to the nucleus. Yet, $1s^7$ is not observed because it violates
(a) Heisenberg uncertainty principle
(b) Hund's rule
(c) Pauli's exclusion principle
(d) Bohr's postulates of stationary orbits.

8. Amoxicillin is semi-synthetic modification of
(a) penicillin (b) streptomycin
(c) tetracycline (d) chloramphenicol.

9. The decreasing order of the ionisation potential of the following elements is
(a) Ne > Cl > P > S > Al > Mg
(b) Ne > Cl > P > S > Mg > Al
(c) Ne > Cl > S > P > Mg > Al
(d) Ne > Cl > S > P > Al > Mg

10. Which of the following factors is of no significance for roasting sulphide ores to the oxides and not subjecting the sulphide ores to carbon reduction directly?
(a) CO_2 is more volatile than CS_2.
(b) Metal sulphides are thermodynamically more stable than CS_2.
(c) CO_2 is thermodynamically more stable than CS_2.
(d) Metal sulphides are less stable than the corresponding oxides.

11. In the following sequence of reactions, the alkene affords the compound *B*.

$$CH_3CH{=}CHCH_3 \xrightarrow{O_3} A \xrightarrow{Zn/H_2O} B$$

The compound *B* is
(a) CH_3CHO (b) CH_3CH_2CHO
(c) CH_3COCH_3 (d) $CH_3CH_2COCH_3$

12. The volume of a colloidal particle, V_c as compared to the volume of a solute particle in a true solution V_s could be

(a) ~ 1 (b) ~ 10^{23}

(c) ~ 10^{-3} (d) ~ 10^{3}

13. The isomeric *cis*-but-2-ene and *trans*-but-2-ene can be distinguished on the basis of

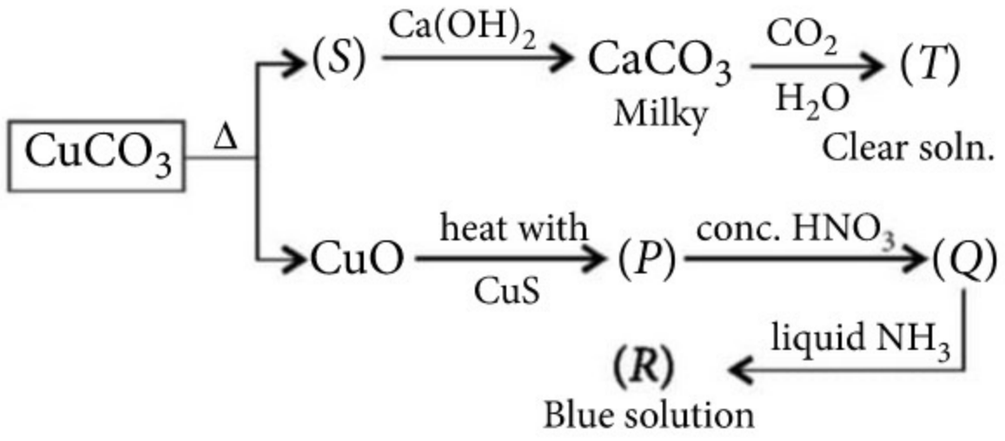
(a) their physical states

(b) their reduction products

(c) the products they give on ozonolysis

(d) the products they give on addition of bromine.

14.



Identify *P*, *R*, *S* and *T*

	P	***R***	***S***	***T***
(a)	Cu	CO_2	$Ca(HCO_3)_2$	$[Cu(NO_3)_4]^{2+}$
(b)	Cu_2S	Cu	Cu_2O	$Ca(HCO_3)_2$
(c)	Cu	$[Cu(NH_3)_4]^{2+}$	CO_2	$Ca(HCO_3)_2$
(d)	CO_2	$[Cu(NO_3)_4]^{2+}$	Cu_2O	$Ca(HCO_3)_2$

15. Which of the following has $p\pi$-$d\pi$ bonding?

(a) NO_3^- (b) SO_3^{2-}

(c) BO_3^{3-} (d) CO_3^{2-}

16. The degree of hardness of water is usually expressed in terms of

(a) parts per million by weight of $MgSO_4$

(b) grams per litre of $CaCO_3$ and $MgCO_3$ actually present

(c) parts per million by weight of $CaCO_3$ regardless of whether it is actually present

(d) parts per million of $CaCO_3$ actually present in water.

17. The emf of a Daniell cell at 298 K is E_1

$Zn \mid ZnSO_4(0.01\ M) \parallel CuSO_4\ (1.0\ M) \mid Cu$

When the concentration of $ZnSO_4$ is 1.0 M and that of $CuSO_4$ is 0.01 M, the emf is changed to E_2.

What is the relationship between E_1 and E_2?

(a) $E_2 = 0 \approx E_1$ (b) $E_1 > E_2$

(c) $E_1 < E_2$ (d) $E_1 = E_2$

18. Which of the following does not show optical isomerism?

(a) $[Co(NH_3)_3Cl_3]$ (b) $[Co(en)_3]Cl_3$

(c) $[Co(en)_2Cl_2]Cl$ (d) $[Co(en)(NH_3)_2Cl_2]Cl$

19. 29.5 mg of an organic compound containing nitrogen was digested according to Kjeldahl's method and the evolved ammonia was absorbed in 20 mL of 0.1 M HCl solution. The excess of the acid required 15 mL of 0.1 M NaOH solution for complete neutralisation. The percentage of nitrogen in the compound is

(a) 29.5 (b) 59.0 (c) 47.4 (d) 23.7

20. The basic character of the transition metal monoxides follows the order

(a) VO > CrO > TiO > FeO

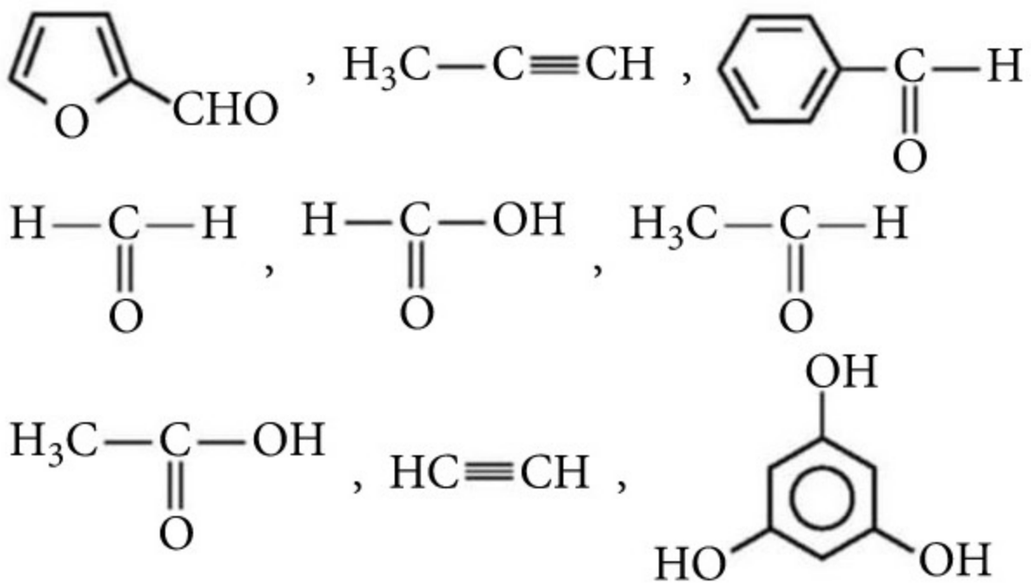
(b) CrO > VO > FeO > TiO

(c) TiO > FeO > VO > CrO

(d) TiO > VO > CrO > FeO

NUMERICAL VALUE TYPE

21. Among the following, how many of them will give positive test with Tollens' reagent?



22. The isotopic composition of rubidium is ^{85}Rb, 72% and ^{87}Rb, 28%. ^{87}Rb is weakly radioactive and decays by β-emission with a decay constant of 1.1×10^{-11} per year. A sample of the mineral pollucite was found to contain 450 mg of Rb and 0.72 mg of ^{87}Sr. The age of pollucite is

23. How many moles of given compound (NaOCl) are decomposed in the following reaction to form one mole of $NaClO_3$?

$$NaOCl \xrightarrow{\Delta} NaClO_3 + NaCl$$

24. Consider the following list of reagents: Acidified $K_2Cr_2O_7$, alkaline $KMnO_4$, $CuSO_4$, H_2O_2, Cl_2, O_3, $FeCl_3$, and $Na_2S_2O_3$. The total number of reagents that can oxidize aqueous iodide to iodine is

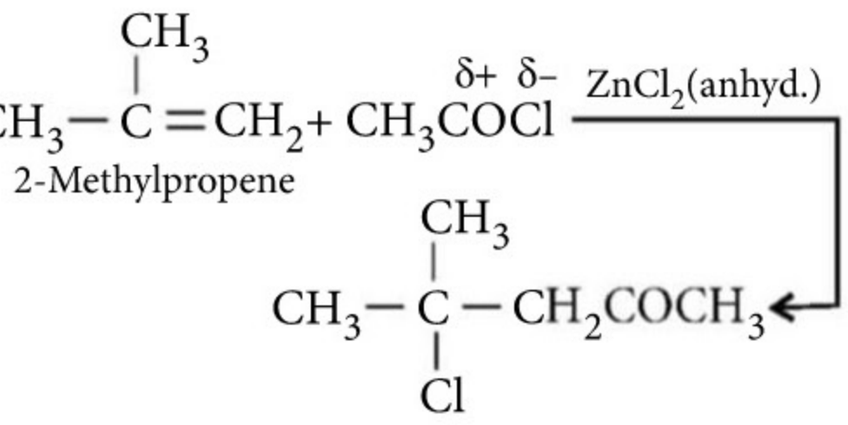
25. Consider the following complex :
Dichloro*bis*(ethylenediamine)chromium (III) chloride
Number of electrons in e_g orbital = X

One mole complex $\xrightarrow[\text{(Excess)}]{AgNO_3}$ Y mole of AgCl

Total stereoisomeric forms of above complex = Z
Find the sum of $(X + Y + Z)$.

SOLUTIONS

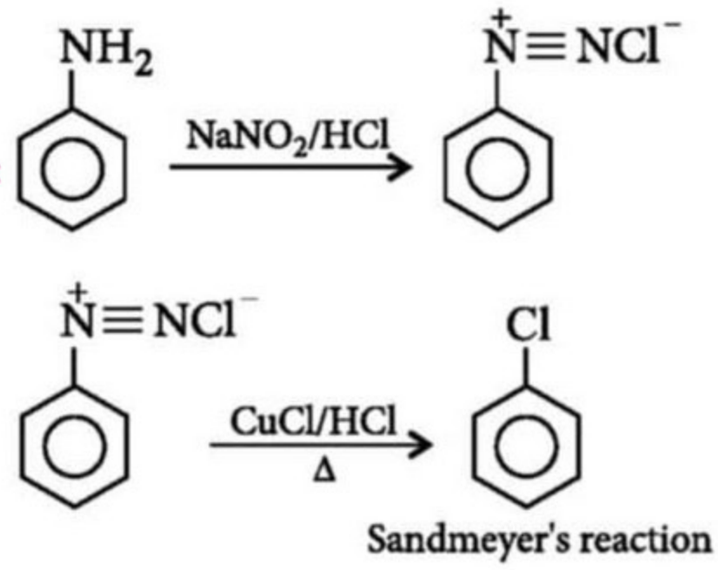
1. (c) :



2. (b): In phospholipids, two of the three hydroxyl groups of glycerol are esterified with two carboxylic acids and third hydroxyl group is esterified with some derivative of phosphoric acid.

3. (b): Cs^+ being least hydrated shows maximum ionic mobility and thus, highest conductivity.

4. (a) :

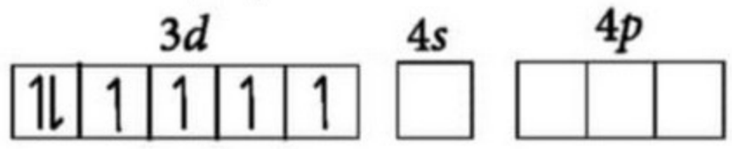


5. (c) : Octahedral voids occupy the position of edge centre and body centre.

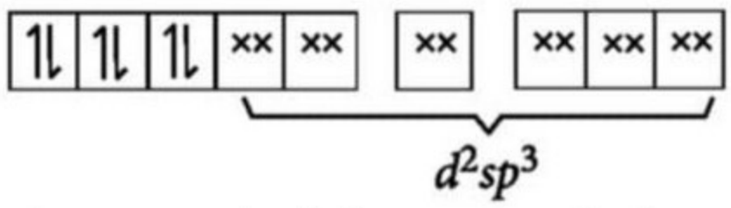
6. (d): $[Co(CN)_6]^{3-}$

$Co \rightarrow [Ar]\ 3d^7\ 4s^2$

$Co^{3+} \rightarrow [Ar]\ 3d^6\ 4s^0$



In presence of strong field ligand CN^-, pairing of electrons takes place.



There is no unpaired electron, so the lowest value of paramagnetic behaviour is observed.

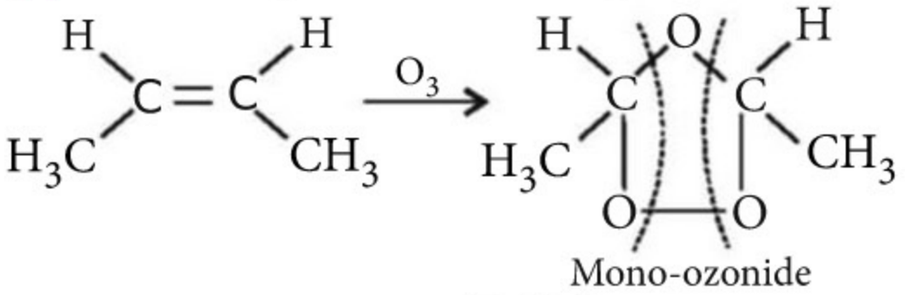
7. (c) : According to Pauli's exclusion principle an orbital can accommodate a maximum of two electrons.

8. (a) : Amoxicillin (an antibiotic) is semi-synthetic modification of penicillin.

9. (b) : Ionisation energy increases from left to right in a period but ionisation energy of group-2 is greater than ionisation energy of group-13 and ionisation energy of group-15 is greater than ionisation energy of group-16.
This is because of stable electronic configuration of group 2 (ns^2) and group 15 (ns^2np^3). Thus, order of ionisation potential is Ne > Cl > P > S > Mg > Al.

10. (d): The reduction process of metal sulphides by carbon is non-spontaneous while the reduction process of metal oxides by carbon is spontaneous. Thus, it can be concluded that CO_2 is thermodynamically more stable than CS_2 and the metal sulphides are more stable than the corresponding oxides.

11. (a): The complete reaction sequence is as follows :



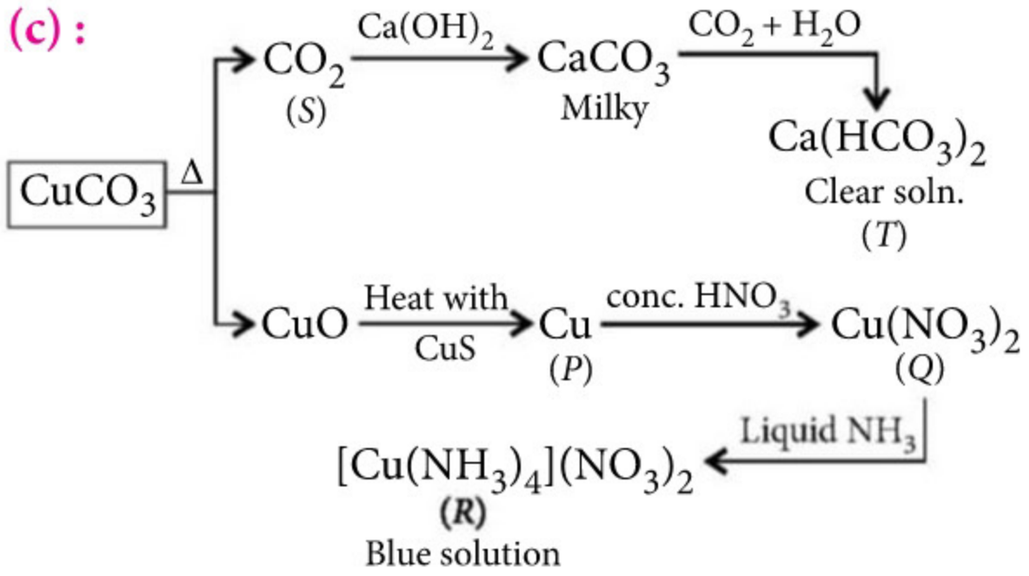
12. (d): For true solution the diameter range is 1 to 10 Å and for colloidal solution diameter range is 10 to 1000 Å.

$$\frac{V_c}{V_s} = \frac{(4/3)\pi r_c^{\,3}}{(4/3)\pi r_s^{\,3}} = \left(\frac{r_c}{r_s}\right)^3$$

Ratio of diameters $= \left(\frac{10}{1}\right)^3 = 10^3$; $\frac{V_c}{V_s} \simeq 10^3$

13. (d): *cis*-but-2-ene yields racemic mixture whereas *trans*-but-2-ene gives the meso compound on addition of bromine.

14. (c) :



15. (b): In SO_3^{2-}, *d*-orbital of sulphur overlaps with *p*-orbital of oxygen to form $p\pi$-$d\pi$ bond. N, B and C do not have *d*-orbitals.

16. (c) : Degree of hardness of water is expressed in terms of parts per million by weight of $CaCO_3$ equivalent to various calcium and magnesium salts present.

17. (b): Daniell cell reaction :

$Cu^{2+} + Zn \rightarrow Zn^{2+} + Cu$; $n = 2$

$$E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{2}\log\frac{[Zn^{2+}]}{[Cu^{2+}]}$$

$$E_1 = E^{\circ}_{cell} - \frac{0.0591}{2}\log\frac{0.01}{1.0},$$

$$E_2 = E^{\circ}_{cell} - \frac{0.0591}{2}\log\frac{1.0}{0.01}$$

On increasing $[Zn^{2+}]$ and decreasing $[Cu^{2+}]$, E_2 becomes less than E_1 *i.e.*, $E_1 > E_2$.

18. (a) : Octahedral complexes of type $[MA_3B_3]$ does not show optical isomerism.

19. (d): The % of N according to Kjeldahl's method

$$= \frac{1.4 \times N_1 \times V}{w}$$

N_1 = Normality of the standard acid = 0.1 N

w = Mass of the organic compound taken

$= 29.5 \text{ mg} = 29.5 \times 10^{-3}$ g

V = Volume of N_1 acid neutralised by ammonia

$= (20 - 15) = 5$ mL

$$\Rightarrow \quad \%N = \frac{1.4 \times 0.1 \times 5}{29.5 \times 10^{-3}} = 23.7$$

20. (d): Metal oxide with more ionic character will be more basic. Ionic radii of metal ion decreases from Ti^{2+} to Fe^{2+}, the basic character of their metal oxides decrease from TiO to FeO. Thus, order of basic character is TiO > VO > CrO > FeO.

21. (7)

22. (5.18×10^8) : Given that, total mass of Rb $= 450 \times 10^{-3}$g

$$\therefore \quad \text{mass of } {}^{87}Rb\ (28\%) = \frac{450\times10^{-3}\times28}{100}\text{ g}$$

$$\text{mass of } {}^{85}Rb\ (72\%) = \frac{450\times10^{-3}\times72}{100}\text{ g}$$

mass of $^{87}Sr = 0.72 \times 10^{-3}$g

Since ^{87}Sr is formed by β-decay of ^{87}Rb as given below:

$$^{87}Rb \longrightarrow {}^{87}Sr + {}^{0}_{-1}e$$

Thus, moles of ^{87}Rb present after time t,

$$= \frac{450\times10^{-3}\times28}{100\times87} = 1.4483 \times 10^{-3} \text{ mole}$$

Also, initial moles of ^{87}Rb = moles of ^{87}Rb present at time t + moles of ^{87}Sr formed at time t

$$= 1.448 \times 10^{-3} + \frac{0.72\times10^{-3}}{87}$$

$$= 1.4483 \times 10^{-3} + 8.27 \times 10^{-6} = 1456.57 \times 10^{-6} \text{ mole}$$

$$t = \frac{2.303}{k}\log\frac{N_0}{N_t} = \frac{2.303}{1.1\times10^{-11}}\log\frac{1456.57\times10^{-6}}{1.4483\times10^{-3}}$$

$= 5.18 \times 10^8$ yrs.

23. (3): $3NaOCl_{(aq)} \rightarrow 2NaCl_{(aq)} + NaClO_{3(aq)}$

24. (6): Acidied $K_2Cr_2O_7$, $CuSO_4$, H_2O_2, Cl_2, O_3 and $FeCl_3$ can oxidize iodide to iodine.

25. (4): $[CrCl_2(en)_2]Cl$

Cr^{3+} has three unpaired electrons, $t_{2g}^3\, e_g^0$.

One mole of the complex will give one mole of AgCl. It has two geometrical isomers, the *cis*-isomer shows optical isomerism. Hence, it forms three stereoisomers.

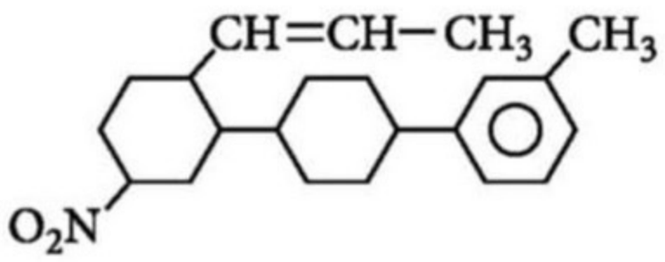
JEE WORK OUTS

JEE Advanced Exam on 27th September, 2020

NUMERICAL VALUE TYPE

1. Solute *A* is a ternary electrolyte and solute *B* is a non-electrolyte. If 0.1 M solution of solute *B* produces an osmotic pressure of 2 π then 0.05 M solution of *A* at the same temperature will produce osmotic pressure equal to

2. The number of stereocentres present in the given compound is



3. The maximum number of carbon atoms arranged linearly in the following molecule is

$$H_3C - C{\equiv}C - CH_2 - CH_3$$

4. A covalent molecule AB_3 has pyramidal structure. The sum of numbers of lone pair and bond pair electrons in the molecule is

5. The number of water molecules directly bonded to the metal centre in $CuSO_4 \cdot 5H_2O$ is

6. The number of nodal planes present in σ^*s antibonding orbitals is

7. The dissociation energy of H_2 is 430.53 kJ/mol. If H_2 is exposed to light energy of wavelength 253.7 nm, percentage of light energy consumed is

8. Grams of potassium dichromate required to oxidise 24.82 g of Fe^{2+} in $FeSO_4$ to Fe^{3+}, if the reaction is carried out in an acidic solution is
[At. wt. K = 39 u, Cr = 52 u, Fe = 56 u, S = 32 u, O = 16 u]

9. The number of moles of $KMnO_4$ reduced by one mole of KI in alkaline medium is

10. 0.28 g of an organic compound was heated with conc. H_2SO_4 and then distilled with NaOH to produce NH_3. NH_3 gas is passed through 50 mL $\frac{N}{10}$ H_2SO_4. Remaining acid required 40 mL $\frac{N}{10}$ alkali for complete neutralisation. The percentage of nitrogen in the compound is

11. A compound $A(C_5H_8O_2)$ is reduced to pentane with Zn-Hg/HCl. It forms a dioxime with NH_2OH and also gives positive iodoform and Tollens' tests. The number of ketonic groups present in *A* is

12. In the complex with formula $MCl_3.4H_2O$, the coordination number of the metal *M* is six and there is no molecule of hydration in it. The volume of 1 M $AgNO_3$ solution needed to precipitate the free chloride ions in 200 mL of 0.1 *M* solution of the complex is

13. A weak field complex of Ni^{2+} has magnetic moment value of 2.82 B.M. The number of electrons in the t_{2g} level of Ni^{2+} is

14. 2 g atom of aluminium is treated separately with excess of dil. H_2SO_4 and excess of NaOH, the sum of the simplest ratio of volumes of hydrogen evolved is

15. The dissociation constant of a substituted benzoic acid at 25°C is 1.0×10^{-4}. The pH of a 0.01 M solution of its sodium salt is

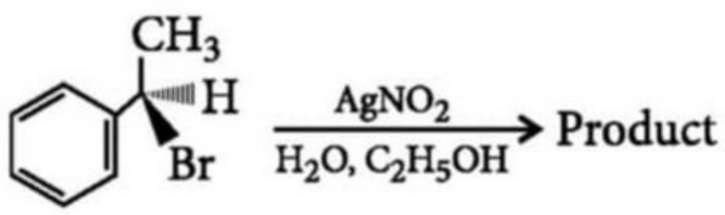
16. Total number of α- and β-particles emitted for the natural $(4n + 1)$ series conversion of $_{94}Pu^{241}$ to $_{92}U^{233}$ is

ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

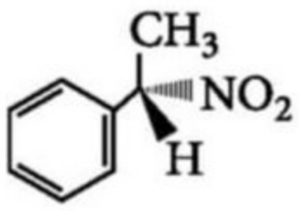
17. In solid ammonia, each NH_3 molecule has six other NH_3 molecules as nearest neighbours. ΔH of sublimation of NH_3 at the melting point is 30.8 kJ mol^{-1} and the estimated ΔH of sublimation in the absence of hydrogen bonding is 14.4 kJ mol^{-1}. Strength of H-bond in solid NH_3 is approximately

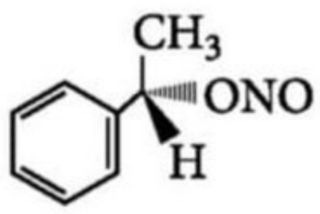
(a) 5.5 kJ mol^{-1} (b) 16.4 kJ mol^{-1}
(c) 2.7 kJ mol^{-1} (d) –2.7 kJ mol^{-1}

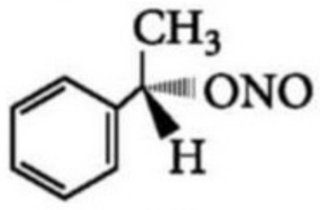
18.



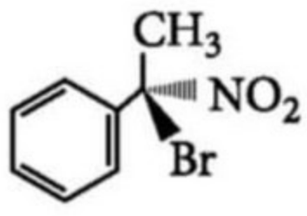
The main product is

(a)


(b)


(c)


+ Enantiomer

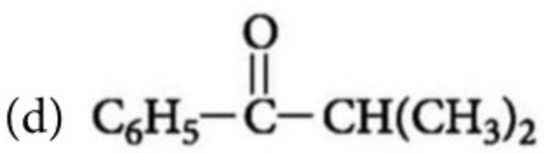
(d)


+ Enantiomer

19. Which of the following molecules contain(s) deuterium after reaction with NaOD in D_2O?

(a) $C_6H_5CH{=}O$ (b)

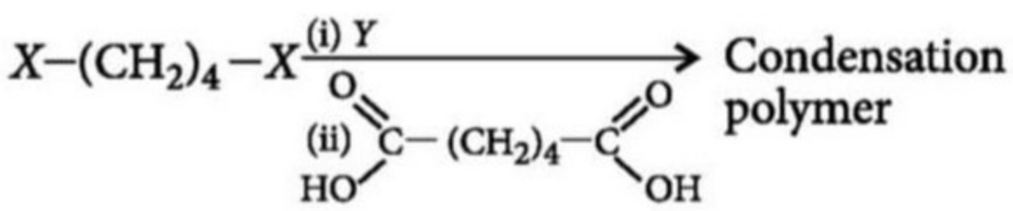

(c) $C_6H_5CH_2CH{=}O$

(d)


20. The reaction of propene with HOCl proceeds *via* the addition of

(a) H^+ in the first step
(b) Cl^+ in the first step
(c) OH^- in the first step
(d) Cl^+ and OH^- in a single step.

21. The correct functional group X and the reagent/reaction conditions Y in the following scheme are



(a) $X = COOCH_3$, $Y = H_2$/Ni/heat
(b) $X = CONH_2$, $Y = H_2$/Ni/heat
(c) $X = CONH_2$, $Y = Br_2$/NaOH
(d) $X = CN$, $Y = H_2$/Ni/heat.

22. Devise a series of reactions to convert ethyl 3-oxobutanoate to ethyl 4-oxopentanoate. Select reagents and conditions from the following table, listing them in the order of use :

(1) Sodium ethoxide in ethanol
(2) Ethanol + Acid catalyst
(3) H_3O^+; heat (4) CO_2; then H_3O^+
(5) Mg in ether (6) PBr_3
(7) $NaBH_4$ in alcohol (8) CH_2I_2 in ether; Zn – Cu
(9) $BrCH_2COOC_2H_5$ (10) $(CH_3CO)_2O$; Pyridine
(a) 1, 9, 3, then 2 (b) 7, 6, 5, 10, then 2
(c) 3, 7, 6, 5, 10, then 2 (d) 8, 3, then 2

23. For the given aqueous reactions, which of the following statement(s) is(are) true?

Excess KI + $K_3[Fe(CN)_6]$ $\xrightarrow[H_2SO_4]{\text{dilute}}$ brownish -yellow solution

$\downarrow ZnSO_4$

white precipitate + brownish-yellow filtrate

$\downarrow Na_2S_2O_3$

colourless solution

(a) The first reaction is a redox reaction.
(b) White precipitate is $Zn_3[Fe(CN)_6]_2$.
(c) Addition of filtrate to starch solution gives blue colour.
(d) White precipitate is soluble in NaOH solution.

24. (Ag + Pb) alloy $\xrightarrow[\text{is added}]{\text{melt and zinc}}$ (Ag + Pb + Zn) melt $\xrightarrow{\text{cool}}$ Layer X / Layer Y

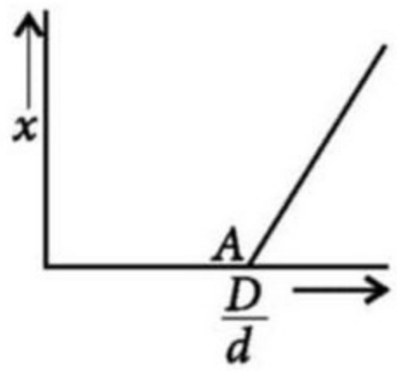
Select the correct statement based on the above scheme :

(a) Layer X contains zinc and silver.
(b) Layer Y contains lead and silver but amount of silver in this layer is smaller than in the layer X.
(c) X and Y are immiscible layers.
(d) All are correct statements.

25. In which of the following cases ($E_{cell} - E°_{cell}$) is zero?

(a) $Cu|Cu^{2+}(0.01\ M)||\ Ag^+\ (0.1\ M)|Ag$
(b) $Pt(H_2)|pH = 1||Zn^{2+}\ (0.01\ M)|\ Zn$
(c) $Pt(H_2)|pH = 1||Zn^{2+}\ (1\ M)|Zn$
(d) $Pt\ (H_2)|H^+\ (0.01\ M)||Zn^{2+}\ (0.01\ M)|\ Zn$

26. Before equilibrium is set-up for the chemical reaction, $N_2O_4 \rightleftharpoons 2NO_2$, vapour density of the gaseous mixture was measured. If D is the theoretical value of vapour density, variation of x with D/d is shown by the following graph.
What is the value of D/d at point A?



(a) 0 (b) 1.5 (c) 1 (d) 0.5

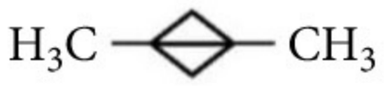
27. For two gases, A and B with molecular weights M_A and M_B, it is observed that at a certain temperature T, the mean velocity of A is equal to the u_{rms} of B. Thus, the mean velocity of A can be made equal to the mean velocity of B, if
(a) A is at temperature T and B at T'; $T > T'$
(b) both A and B are raised to a higher temperature
(c) both A and B are lowered in temperature
(d) none of these.

28. Which of the following reactions are properly interpreted?

(a) $R_2C=CR_2 + :CBr_2 \longrightarrow R_2C(Br)-CR_2(Br) \xrightarrow{Mg} R_2C=C=CR_2$

(b) $Me_2C=CMe_2 \xrightarrow{HCl} \xrightarrow{t\text{-BuOK}}$ $CH_3-CH(CH_3)-C(CH_3)=CH_2$

(c) $(CH_3)_3\overset{+}{N}-CH_2-CH_2-OH \xrightarrow[\Delta]{Ag_2O} CH_3-CHO$

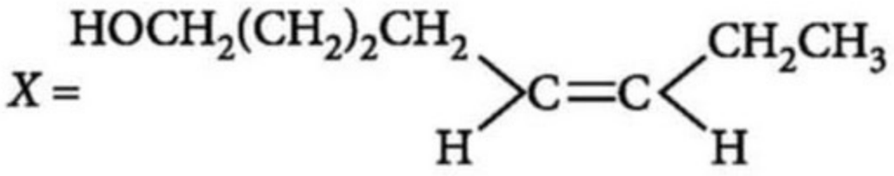
(d) $CH_3-C\equiv C-CH_3 + 2CH_2N_2 \xrightarrow{\Delta}$ 

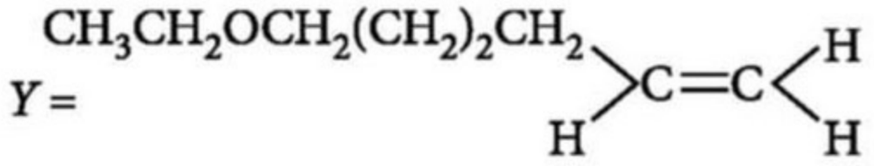
29. $HO-CH_2-(CH_2)_2-CH_2-C\equiv CH\ (A) \xrightarrow{NaNH_2} B$

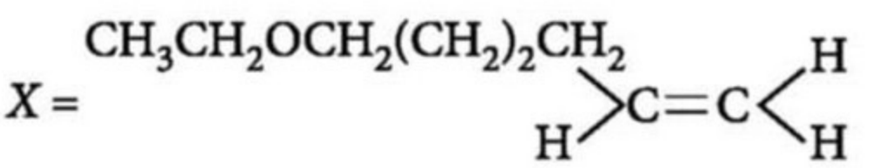
Final product $\xleftarrow[\text{Lindlar's catalyst}]{H_2} D \xleftarrow{EtOH} C \xleftarrow{CH_3CH_2Br}$ (B)

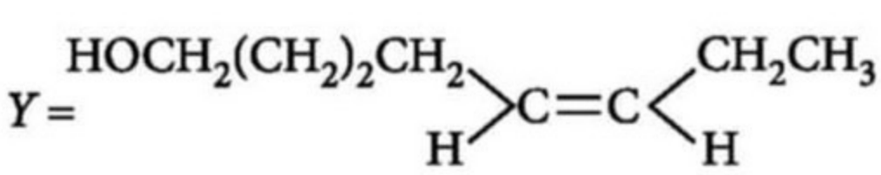
If A is treated with excess of $NaNH_2$, the final product is X and if A is treated with only one equivalent of $NaNH_2$, the final product is Y. (Remaining reagents are reacted as indicated in both the cases). Which of the following justify X and Y correctly?

(a) X and Y both are same molecules but X will be in higher yield.

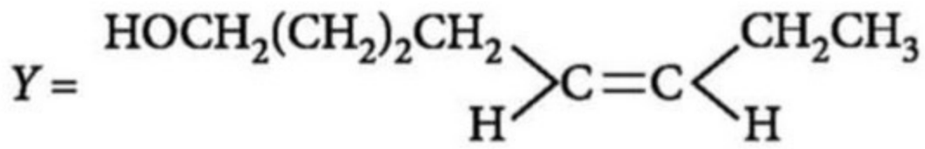
(b) $X =$ 

$Y =$ 

(c) $X =$ 

$Y =$ 

(d) $X = HOCH_2(CH_2)_2CH_2CH_2CH_2CH=CH_2$

$Y =$ 

30. Reaction of $R-\overset{O}{\overset{\|}{C}}-NH_2$ with a mixture of Br_2 and KOH gives $R-NH_2$ as the main product. The intermediates involved in this reaction are

(a) $R-\overset{O}{\overset{\|}{C}}-NHBr$ (b) $R-NHBr$

(c) $R-N=C=O$ (d) $R-\overset{O}{\overset{\|}{C}}-N(Br)(Br)$

31. Among Al_2O_3, SiO_2, P_2O_3 and SO_2, the correct order of acid strength is
(a) $SO_2 < P_2O_3 < SiO_2 < Al_2O_3$
(b) $SiO_2 < SO_2 < Al_2O_3 < P_2O_3$
(c) $Al_2O_3 < SiO_2 < SO_2 < P_2O_3$
(d) $Al_2O_3 < SiO_2 < P_2O_3 < SO_2$

32. Compound (A) $C_8H_{10}O$ reacts with sodium to give colourless and odourless gas and upon vigorous oxidation using $KMnO_4$ gives terephthalic acid, the compound contains
(a) phenolic –OH (b) benzene ring
(c) alkyl group substituted at *meta*-position
(d) alkyl group substituted at *para*-position.

33. In compounds of type ECl_3, where E = B, P, As or Bi, the angles Cl—E—Cl for different E are in the order
(a) B > P = As = Bi (b) B > P > As > Bi
(c) B < P = As = Bi (d) B < P < As < Bi

34. Among the following species, the isostructural pairs are NF_3, NO_3^-, BF_3, H_3O^+, HN_3

(a) [NF_3, NO_3^-] and [BF_3, H_3O^+]

(b) [NF_3, HN_3] and [NO_3^-, BF_3]

(c) [NF_3, H_3O^+] and [NO_3^-, BF_3]

(d) [NF_3, H_3O^+] and [HN_3, BF_3]

COLUMN-MATCHING TYPE

35. Match the appropriate metals in Column I with the extraction processes in Column II.

	Column I		Column II
(A)	Silver	(P)	Fused salt electrolysis
(B)	Calcium	(Q)	Carbon reduction
(C)	Zinc	(R)	Carbon monoxide reduction
(D)	Iron	(S)	Amalgamation

	A	B	C	D
(a)	P	R	Q	S
(b)	S	P	Q	R
(c)	S	Q	R	P
(d)	P	S	R	Q

36. Match the expressions in Column I with the variables in Column II.

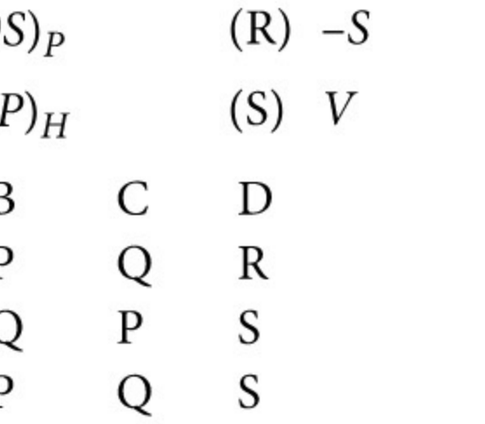
	Column I		Column II
(A)	$(\partial G/\partial P)_T$	(P)	μ_{JT}
(B)	$(\partial G/\partial T)_P$	(Q)	T
(C)	$(\partial H/\partial S)_P$	(R)	$-S$
(D)	$(\partial T/\partial P)_H$	(S)	V

	A	B	C	D
(a)	S	P	Q	R
(b)	R	Q	P	S
(c)	R	P	Q	S
(d)	S	R	Q	P

PARAGRAPH TYPE

PARAGRAPH 1

The progress of the reaction, $A \rightleftharpoons nB$ with time is represented in the following figure :



37. What is the value of n?

(a) 1 (b) 2 (c) 3 (d) 4

38. Find the value of the equilibrium constant.

(a) 0.6 M (b) 1.2 M (c) 0.3 M (d) 2.4 M

PARAGRAPH 2

When Grignard reagent is treated with water, alcohol, ammonia, 1° amine, 2° amine, 1-alkyne or carboxylic acid, we get alkane corresponding to alkyl part of Grignard reagent. In Grignard reagent, C-atom is more electronegative than magnesium hence, its alkyl part acts as nucleophile and thus it will take an active hydrogen atom (H-atom that undergoes acylation) or acidic hydrogen atom to give its corresponding alkane. Also, it is known that stronger acid displaces weak acid from weak acid salt.

39. Structure of hydrocarbon, 0.34 g of which when treated with CH_3MgI liberates 112 mL of CH_4 at STP, will be

(a) $CH_3CH(CH_3)-C\equiv C-H$ (b) $CH_3-C\equiv C-H$

(c) $CH_3-CH_2-C\equiv C-H$

(d) $CH_3-CH_2-CH(CH_3)-C\equiv C-H$

40. Molecular formula of the alcohol, 0.44 g of which when treated with CH_3MgI liberates 112 mL of CH_4 is

(a) C_5H_9OH (b) C_4H_9OH

(c) $C_6H_{13}OH$ (d) $C_5H_{11}OH$

SOLUTIONS

PAPER-I

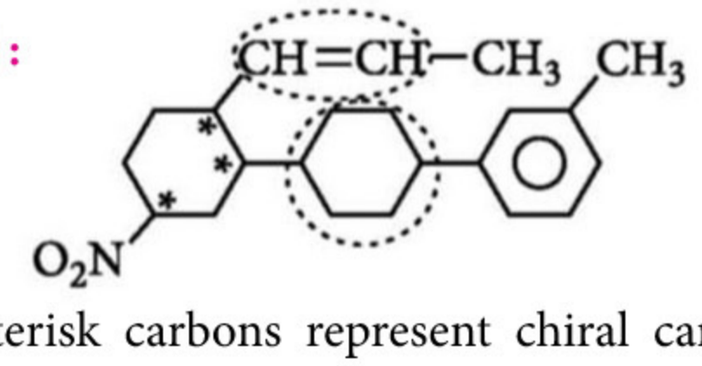
1. **(9.43):** 0.05 M solution of $A \rightarrow 0.05 \times 3$ M ion $= 0.15$ M

0.1 M solution of B has osmotic pressure = 2π

0.15 M solution will have osmotic pressure

$$= \frac{2\pi}{0.1} \times 0.15 = 9.43$$

2. **(5):**



Asterisk carbons represent chiral carbons which will show apical isomerism while carbons in the dotted region will show geometrical isomerism.

3. **(4):** *sp*-hybridised carbon atoms as well as carbon atoms directly attached to it are linearly arranged.

$$\overset{sp}{H_3C}-\overset{sp}{C}\equiv C-CH_2-CH_3$$

So, total number = 4

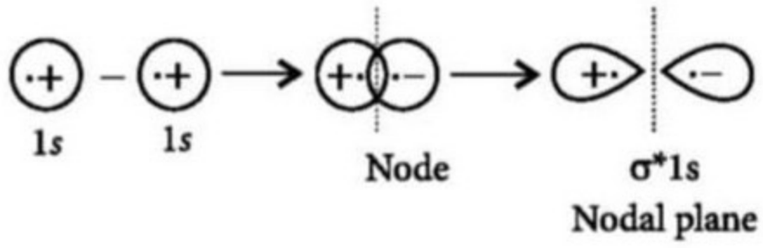
4. (4): In general, a compound with formula AB_3 is sp^2-hybridised with triangular planar geometry. However, the given compound has pyramidal structure which is possible only when it has a lone pair of electrons. Thus, AB_3 has three bond pairs and one lone pair.

Sum = 3 + 1 = 4

5. (4): Hydrated copper sulphate or $CuSO_4 \cdot 5H_2O$ is blue in colour and this colour is attributed to the presence of hydrated Cu(II) ion, *i.e.*, $[Cu(H_2O)_4]^{2+}$. Thus, the number of water molecules directly attached to Cu^{2+} or present within the coordination sphere is 4.

$\therefore$ $CuSO_4 \cdot 5H_2O$ can be written as $[Cu(H_2O)_4]SO_4 \cdot H_2O$.

6. (1): The molecular orbital σ^*s is formed by the subtractive overlapping of two *s*-orbitals.



7. (91.2) : Energy associated with H_2 molecule corresponding to wavelength 253.7 nm $= \frac{hc}{\lambda}$

$$= \frac{6.63\times10^{-34}\times3\times10^{8}}{253.7\times10^{-9}} = 7.84\times10^{-19}\ \text{J}$$

$= 7.84 \times 10^{-19} \times 6.02 \times 10^{23}$ J/mol $= 472 \times 10^3$ J/mol

% of light energy consumed

$$= \frac{430.53\times10^{3}}{472\times10^{3}} \times 100 = 91.2\%$$

8. (8): When dissolved in water, $K_2Cr_2O_7$ dissociates into K^+ and $Cr_2O_7^{2-}$ ions and $FeSO_4$ dissociates into Fe^{2+} and SO_4^{2-} ions. The skeleton equation is :

$Fe^{2+} + Cr_2O_7^{2-} \rightarrow Fe^{3+} + 2Cr^{3+}$

The balanced chemical equation is

$Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$

From the balanced chemical equation, it is clear that

1 mol $K_2Cr_2O_7 \equiv$ 6 mol $FeSO_4$

Formula weight of $K_2Cr_2O_7 = 2\times39 + 2\times52 + 7\times16$

$= 294$ g mol^{-1}

Formula weight of $FeSO_4 = 152$ g mol^{-1}

1 mol $K_2Cr_2O_7 \equiv$ 6 mol $FeSO_4$

1×294 $\quad$ 6×152

6×152 g $FeSO_4$ require $K_2Cr_2O_7 = 294$ g

24.82 g of $FeSO_4$ will require $K_2Cr_2O_7$

$$= \frac{294}{6\times152}\times24.82\ \text{g} = 8\ \text{g}$$

9. (2): In alkaline medium :

$2KMnO_4 + H_2O \longrightarrow 2KOH + 2MnO_2 + 3[O]$

$KI + 3[O] \longrightarrow KIO_3$

So, overall reaction is

$2KMnO_4 + KI + H_2O \longrightarrow 2KOH + 2MnO_2 + KIO_3$

10. (5): % age of nitrogen $= \frac{1.4}{W}(N_1V_1 - N_2V_2)$

$$= \frac{1.4}{0.28}\left(50\times\frac{1}{10} - 40\times\frac{1}{10}\right) = \frac{1.4}{0.28}(5-4)$$

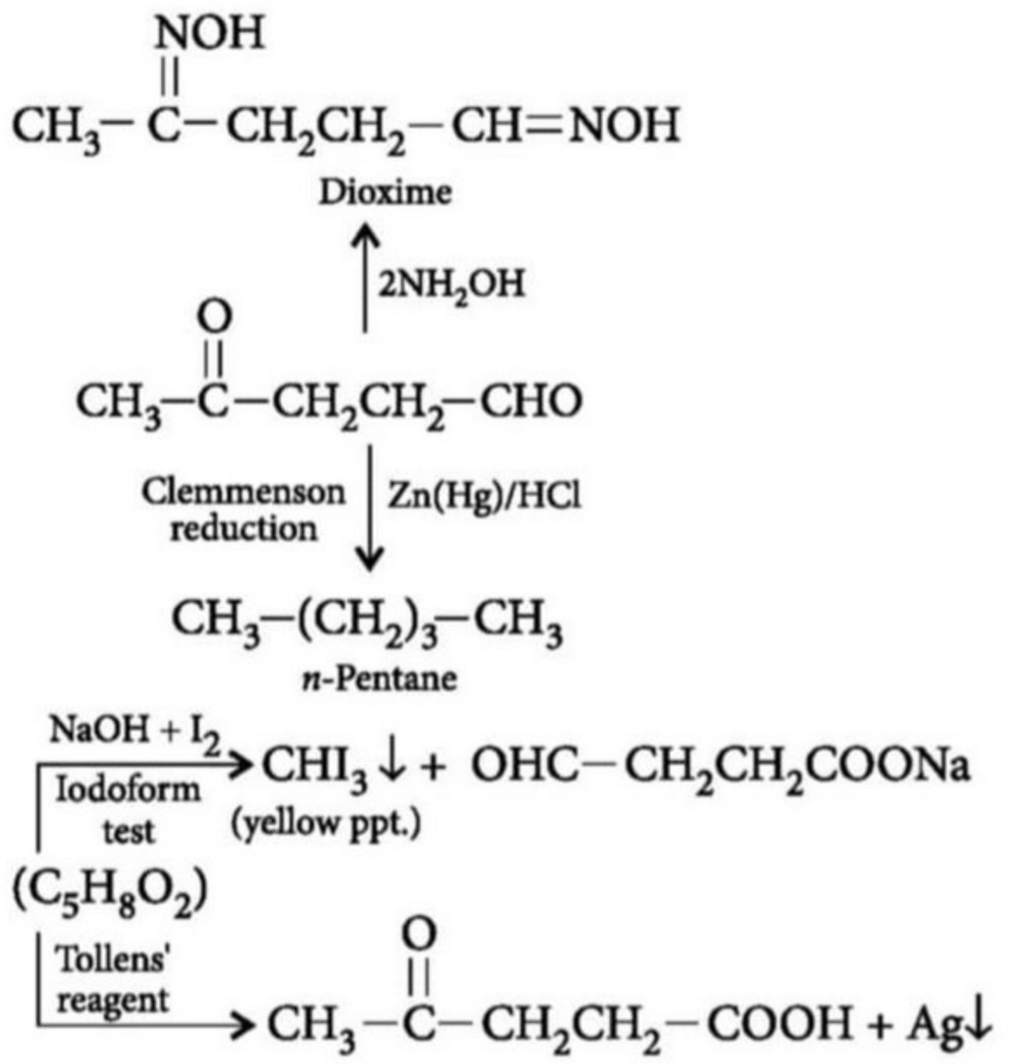
$$= \frac{1.4\times1}{0.28} = 5\%$$

11. (1): (i) The compound gives positive iodoform test indicating the presence of $CH_3-\overset{\overset{O}{\|}}{C}-$ group.

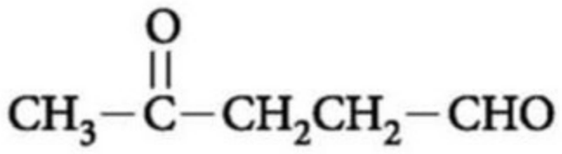
(ii) It also gives positive Tollens' test indicating the presence of –CHO group.

(iii) The presence of one keto and one aldehydic group in the compound is indicated by its reaction with NH_2OH forming a dioxime.

(iv) Both keto as well as aldehydic group can be reduced to hydrocarbon (alkane) through Clemmenson reduction.



Hence, the structure of the given compound is



$\therefore$ The number of ketonic groups is 1.

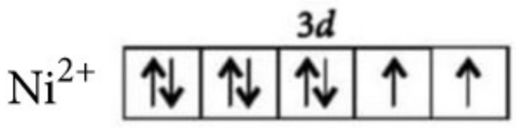
12. (20) : The complex with formula $MCl_3 \cdot 4H_2O$, with no molecule of hydration is $[MCl_2(H_2O)_4]Cl$, so, one chlorine is ionisable.

$\therefore$ No. of equivalents of Ag^+ = No. of equivalents of Cl^- in solution.

$1 \times V = 200 \times 0.1 \therefore V = 20$ mL

13. (6) : $\mu = 2.82 = \sqrt{n(n+2)} \Rightarrow n = 2$

Since, Ni^{2+} has two unpaired electrons so, its configuration will be



In weak field complexes, first the t_{2g} and e_g levels are singly occupied and then the pairing of electrons in t_{2g} level takes place. Thus, there are 6 electrons in t_{2g} level.

14. (2) : $2Al + 2NaOH + 6H_2O \xrightarrow{\Delta} \underset{\text{Sodium metaaluminate}}{2Na[Al(OH)_4]} + 3H_2$

Al dissolves in dil. HCl and dil. H_2SO_4 slowly liberating 3 moles H_2 gas.

$2Al + 3H_2SO_4 \longrightarrow Al_2(SO_4)_3 + 3H_2$

Hence, the ratio of volumes of H_2 evolved is 1 : 1.

Sum of the ratio = 1 + 1 = 2.

15. (8) : Given, $K_a = 1 \times 10^{-4}$

$\therefore \quad pK_a = -\log(1 \times 10^{-4}) = 4$

$C = 0.01$ M

Since the solution contains a salt of weak acid and strong base,

$$\therefore \quad pH = 7 + \frac{1}{2}pK_a + \frac{1}{2}\log C$$

$$= 7 + \frac{1}{2} \times 4 + \frac{1}{2} \times \log(0.01) = 9 + \frac{1}{2} \times (-2) = 8$$

$\therefore$ pH of solution = 8.

16. (4) : $(4n + 1)$ Neptunium series

$$^{241}_{94}Pu \xrightarrow{-\beta} {}^{241}_{95}Am \xrightarrow{-\alpha} {}^{237}_{93}Np \xrightarrow{-\alpha} {}^{233}_{91}Pa \xrightarrow{-\beta} {}^{233}_{92}U$$

2α and 2β particles are emitted.

17. (a) : Total strength of all hydrogen bonds

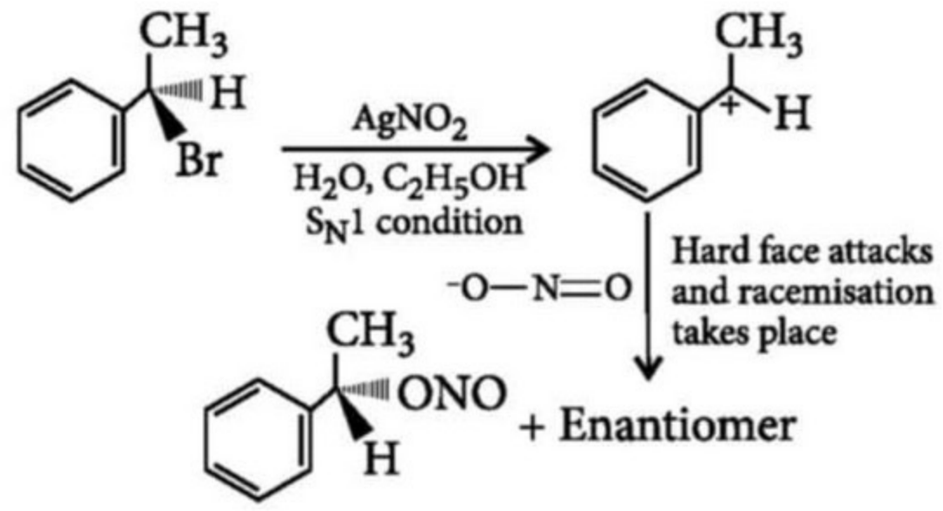
$= 30.8 - 14.4 = 16.4$ kJ mol^{-1}

There are six nearest neighbours, but each hydrogen bond involves 2 molecules.

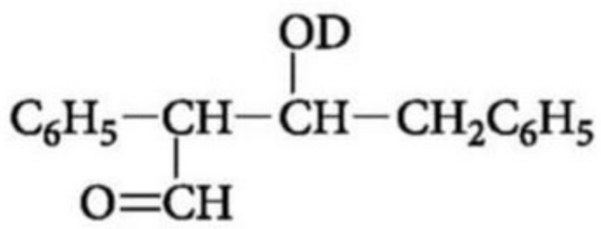
$\therefore$ Effective neighbours = 3

Hence, strength of H-bond $= \frac{16.4}{3} = 5.5$ kJ mol^{-1}

18. (c) :



19. (c, d) : $2C_6H_5CH_2CH{=}O \xrightarrow{NaOD,\ D_2O}$



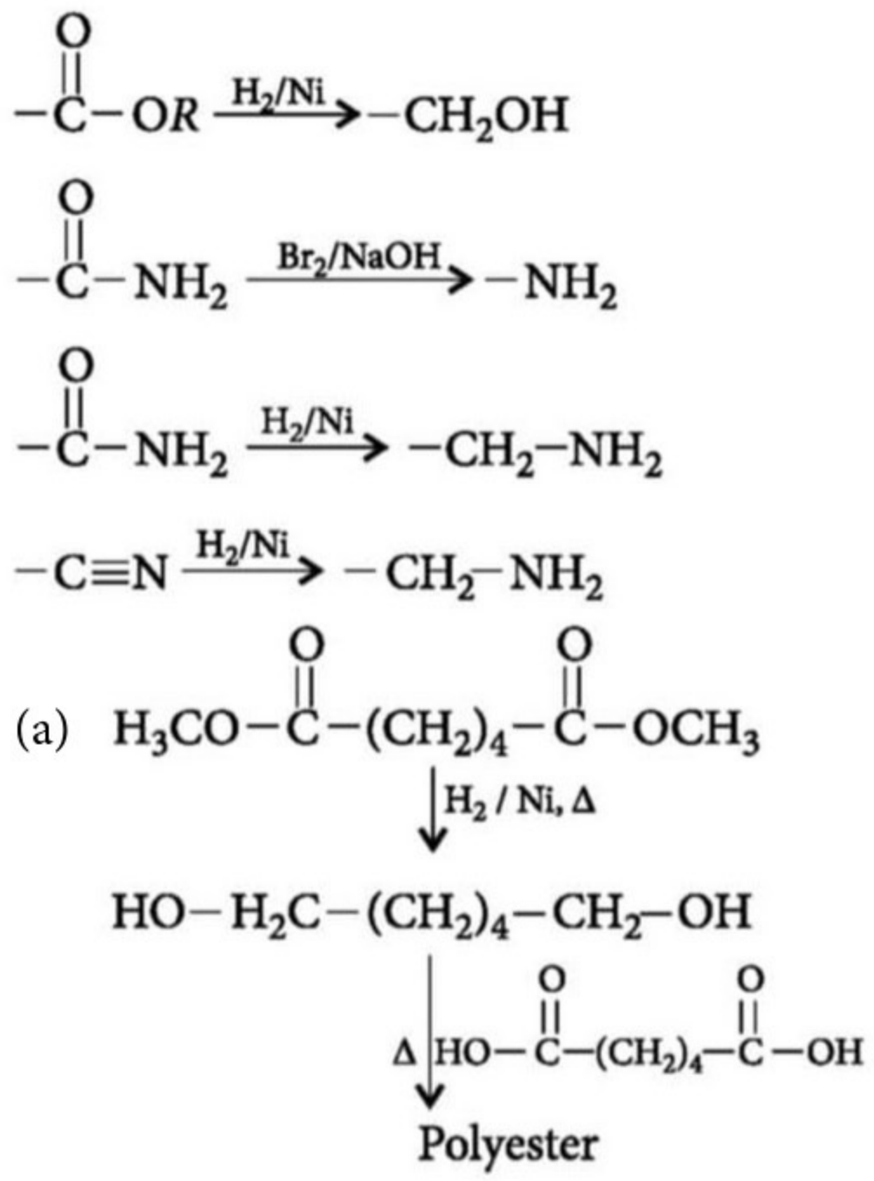
The reactions occurs similarly with $C_6H_5COCH(CH_3)_2$.

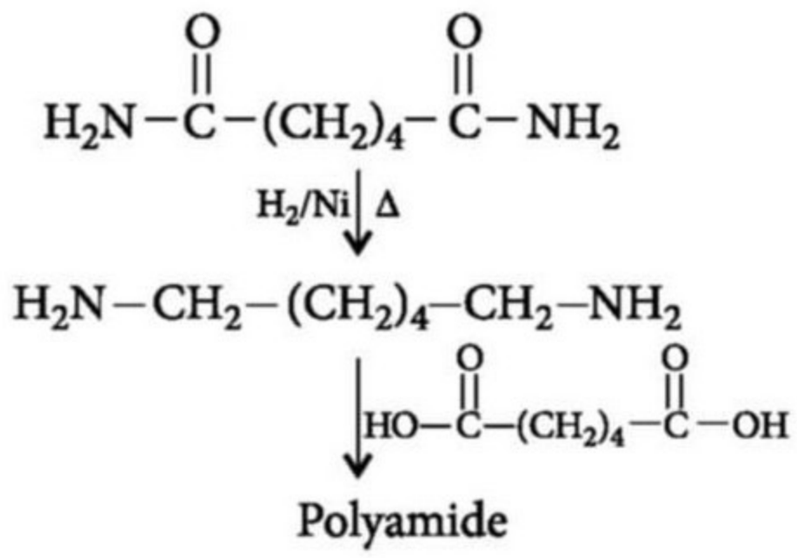
20. (b) : Alkenes undergo electrophilic addition reactions. HOCl on self-ionisation produces Cl^+ which attacks first.

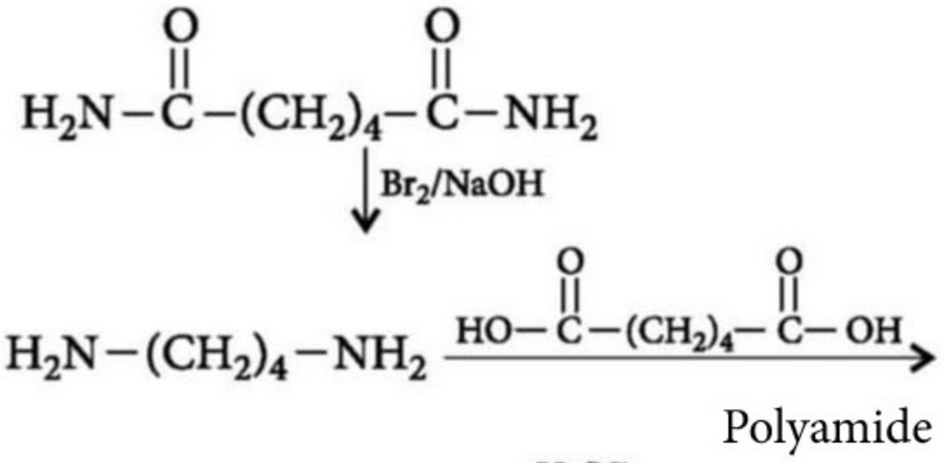
$HOCl + HOCl \longrightarrow H_2O + OCl^- + Cl^+$

21. (a, b, c, d) : Condensation polymers are formed by condensation of diols or diamines with dicarboxylic acids. Therefore,

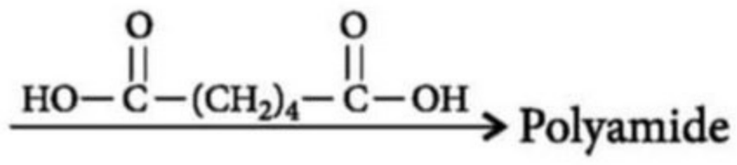
X may be; $-\overset{O}{\overset{\|}{C}}-OR$ or $-\overset{O}{\overset{\|}{C}}-NH_2$ or $-C{\equiv}N$



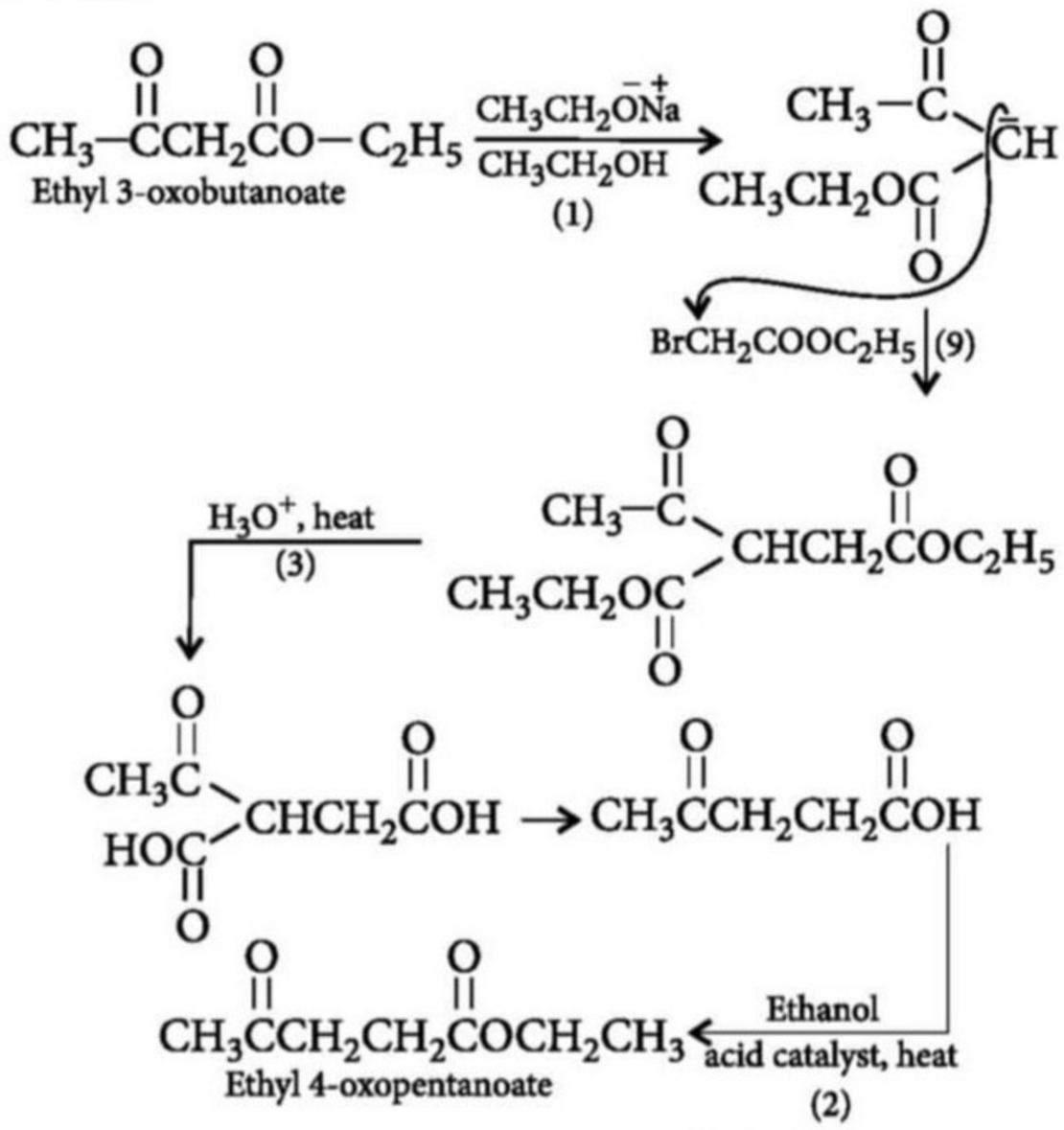
(b) 

(c) 

(d) $N \equiv C-(CH_2)_4-C \equiv N \xrightarrow{H_2/Ni} H_2NCH_2-(CH_2)_4-CH_2NH_2$



22. (a) :



23. (a, c, d) : $2KI + 2K_3[Fe(CN)_6] \xrightarrow{\text{dil. } H_2SO_4} 2K_4[Fe(CN)_6] + I_2$ ... (i)

$I_2 + KI \longrightarrow KI_3$ ... (ii)

(excess) (brownish-yellow filtrate)

$K_4[Fe(CN)_6] + ZnSO_4 \longrightarrow K_2Zn_3[Fe(CN)_6]_2$

White ppt.

$KI_3 + 2Na_2S_2O_3 \longrightarrow Na_2S_4O_6 + 2NaI + KI$

Brownish-yellow filtrate (Colourless solution)

(a) is correct as in reaction (i), I^- (–1) is being oxidised to I_2(0) and Fe^{3+} is being reduced to Fe^{2+}.

(b) is incorrect as white precipitate is of $K_2Zn_3[Fe(CN)_6]_2$ or $Zn_2[Fe(CN)_6]$

(c) is correct as

$I_3^- \rightleftharpoons I^- + I_2$

filtrate

I_2 + starch $\longrightarrow$ Blue colour

(d) is correct as white precipitate of $K_2Zn_3[Fe(CN)_6]_2$ or $Zn_2[Fe(CN)_6]$ is soluble in NaOH as

$Zn_2[Fe(CN)_6] + 8NaOH \longrightarrow 2Na_2[Zn(OH)_4] + Na_4[Fe(CN)_6]$

Soluble

24. (d): Zinc and lead in molten state are immiscible and form separate layers, zinc being lighter forms upper layer. Ag is soluble in both.

25. (a, b) : (a) $E_{cell} = E^\circ_{cell} - \frac{2.303RT}{2F}\log\frac{[Cu^{2+}]}{[Ag^+]^2}$

$$E_{cell} - E^\circ_{cell} = -\frac{2.303RT}{2F}\log\frac{0.01}{(0.1)^2}$$

$$E_{cell} - E^\circ_{cell} = 0$$

(b) $$E_{cell} - E^\circ_{cell} = -\frac{2.303RT}{2F}\log\frac{[H^+]^2}{[Zn^{2+}]}$$

$$= -\frac{2.303RT}{2F}\log\frac{(1\times10^{-1})^2}{(0.01)} = 0$$

(c) $E_{cell} - E^{\circ}_{cell} = -\dfrac{2.303RT}{2F}\log\dfrac{[H^+]^2}{[Zn^{2+}]}$

$= -\dfrac{2.303RT}{2F}\log\dfrac{(1\times10^{-1})^2}{1} \neq 0$

(d) $E_{cell} - E^{\circ}_{cell} = -\dfrac{2.303RT}{2F}\log\dfrac{[H^+]^2}{[Zn^{2+}]}$

$= -\dfrac{2.303RT}{2F}\log\dfrac{(0.01)^2}{(0.01)} \neq 0$

26. (c) : $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$

Degree of dissociation, $x = \dfrac{D-d}{d}$ or $x = \dfrac{D}{d} - 1$

At $A, x = 0$

$\therefore \quad \dfrac{D}{d} - 1 = 0$ or $\dfrac{D}{d} = 1$

27. (d): $\sqrt{\dfrac{8RT}{\pi M_A}} = \sqrt{\dfrac{3RT}{M_B}}$

$\dfrac{8}{\pi M_A} = \dfrac{3}{M_B} \Rightarrow \dfrac{M_A}{M_B} = \dfrac{8}{3\pi}$

for $\sqrt{\dfrac{8RT}{\pi M_A}} = \sqrt{\dfrac{8RT'}{\pi M_B}}$

$\dfrac{T}{M_A} = \dfrac{T'}{M_B}; \quad \dfrac{3\pi T}{8M_B} = \dfrac{T'}{M_B}$

$\dfrac{T}{T'} = \dfrac{8}{3\pi} \qquad T' > T$

28. (a, b, c, d) : (a) $R_2C{=}CR_2 + :CBr_2 \longrightarrow R_2C(Br)\text{–}CR_2$ (Br, Br) $\xrightarrow{Mg} R_2C{=}C{=}CR_2$

(b) $(CH_3)_2C{=}C(CH_3)_2 \xrightarrow{HCl}$ $CH_3CH(CH_3)\text{–}C(CH_3)(H)\text{–}C(CH_3)(Cl)\text{–}CH_3 \xrightarrow{t\text{-BuOK}} CH_3\text{–}CH(CH_3)\text{–}C(CH_3){=}CH_2$ (Hofmann product)

(c) $(CH_3)_3\overset{+}{N}\text{–}CH_2\text{–}CH(OH)\text{–}H \xrightarrow{\Delta}$

$(CH_3)_3N + H_2C{=}CH\text{–}OH \rightleftharpoons CH_3\text{–}CHO$

(d) $H_2C: + C{\equiv}C + :CH_2 \longrightarrow$ (1,3-dimethylbicyclo[1.1.0]butane)

29. (b):

$HO\text{–}CH_2\text{–}(CH_2)_2\text{–}CH_2\text{–}C{\equiv}CH \xrightarrow[NaNH_2]{Excess} {}^{-}OCH_2(CH_2)_2CH_2\text{–}C{\equiv}C^{-} \xrightarrow{CH_3CH_2Br} {}^{-}OCH_2(CH_2)_2CH_2\text{–}C{\equiv}C\text{–}CH_2CH_3 \xrightarrow{EtOH} HO\text{–}CH_2(CH_2)_2\text{–}CH_2\text{–}C{\equiv}C\text{–}CH_2CH_3$

$HO\text{–}CH_2\text{–}(CH_2)_2\text{–}CH_2\text{–}C{\equiv}CH \xrightarrow[NaNH_2]{One\ eq.} \bar{O}CH_2\text{–}(CH_2)_2\text{–}CH_2\text{–}C{\equiv}CH \xrightarrow{CH_3CH_2Br} CH_3CH_2\text{–}O\text{–}CH_2\text{–}(CH_2)_2\text{–}CH_2\text{–}C{\equiv}CH$

(EtOH is helpful to protonate the acetylide if forms)

$CH_3CH_2OCH_2\text{–}(CH_2)_2\text{–}CH_2$ (H)C=C(H)H (Y)

$HOCH_2(CH_2)_2CH_2$ (H)C=C(H)CH_2CH_3 (X) *cis*-Product

30. (a, c) : This is Hofmann bromamide degradation reaction.

$R\text{–}C(=O)\text{–}NH_2 + Br_2 \longrightarrow R\text{–}C(=O)\text{–}NHBr + HBr$

$R\text{–}C(=O)\text{–}NHBr + OH^- \longrightarrow R\text{–}C(=O)\text{–}\ddot{N}^{\ominus}\text{–}Br + H_2O$

$R\text{–}C(=O)\text{–}\ddot{N}^{\ominus}\text{–}Br + K^+ \longrightarrow R\text{–}C(=O)\text{–}\ddot{N}: + KBr$ (Nitrene)

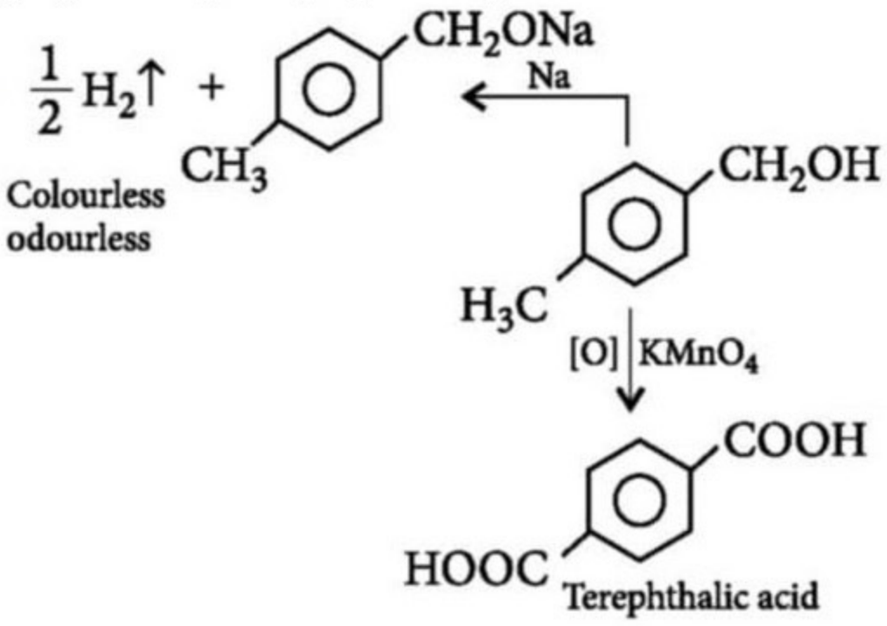
$R\text{–}C(=O)\text{–}\ddot{N}: \rightleftharpoons R\text{–}\ddot{N}{=}C{=}O$

$R\text{–}N{=}C{=}O + 2KOH \longrightarrow RNH_2 + K_2CO_3$

31. (d): Acidic strength of oxides in a period increases from left to right. Thus, the order of acidic strength is

$$Al_2O_3 < SiO_2 < P_2O_3 < SO_2$$

32. (b, d) :



33. (b): In BCl_3, the state of hybridisation,

$$H = \frac{1}{2}(3 + 3 + 0 - 0) = 3 \; i.e., \; sp^2$$

So, the bond angle is 120°.

The state of hybridisation in case of P, As and Bi is sp^3 and due to the presence of a lone pair on the central atom the bond angle is less than normal tetrahedral angle of 109°28′, *i.e.*, bond angle < 109°28′. Since the central atom (P, As, Bi) belong to the same group, the bond angle of ECl_3 decreases as we go down the group, *i.e.*, from P to As to Bi, thus the correct order of bond angles is $BCl_3 > PCl_3 > AsCl_3 > BiCl_3$.

34. (c) : Isostructural compounds have same type of hybridisation.

In NF_3, N is sp^3 hybridised (3 *b.p.* + 1 *l.p.*)

In NO_3^- ; N is sp^2 hybridised.

In BF_3 ; B is sp^2 hybridised.

In H_3O^+ ; O is sp^3 hybridised.

Thus, it can be concluded that NF_3 and H_3O^+ are isostructural and BF_3 and NO_3^- are isostructural.

35. (b) **36. (d)**

37. (b): According to the figure, in the given time of 4 hours (1 to 5) concentration of *A* falls from 0.5 to 0.3 M, while in the same time concentration of *B* increases from 0.2 to 0.6 M.

Decrease in concentration of *A* in 4 hours

$$= 0.5 - 0.3 = 0.2 \text{ M}$$

Increase in concentration of *B* in 4 hours

$$= 0.6 - 0.2 = 0.4 \text{ M}$$

Thus, increase in concentration of *B* in a given time is twice the decrease in concentration of *A*. Thus $n = 2$.

38. (b) : $K = \frac{[B]^2}{[A]} = \frac{(0.6)^2}{0.3} = 1.2 \text{ M}$

39. (a) : $R - C \equiv C - H + CH_3 - MgI \longrightarrow$

$$CH_4 + R - C \equiv C - Mg - I$$

Number of moles of CH_4

= Number of moles of hydrocarbon

$$\frac{112}{22400} = \frac{0.34}{\text{Molar mass}} \Rightarrow \text{Molar mass} = 68$$

$$C_nH_{2n-2} = 68 \Rightarrow n = \frac{68+2}{14} = 5$$

Molecular formula of hydrocarbon,

$R-C\equiv C-H$ is C_5H_8

Hence, $R = C_3H_7$ which may be propyl or isopropyl.

40. (d): Number of moles of alcohol

= Number of moles of CH_4

$$\frac{0.44}{\text{Molar mass}} = \frac{112}{22400} \Rightarrow \text{Molar mass} = 88$$

$$n = \frac{88-18}{14} = 5$$

∴ Molecular formula of alcohol = $C_5H_{11}OH$

❖❖

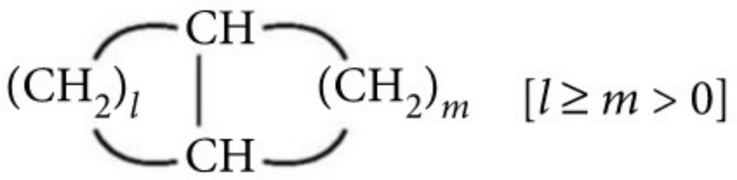
CONCEPT BOOSTER

Hello everyone!!! In the present situation hope you all are fit & fine. Please take care of yourself and your family members. Life is precious. Learning is also precious. Hence do not stop learning. Learning can never be stopped. Education is the oxygen of life. So dear students, at any condition keep learning and keep practicing. We are always beside you. Hence, in this issue I am presenting a super duper article which is unconventional yet very important. Hope you all will like it.

*Arunava Sarkar

FUSED AND BRIDGED POLICYCLIC SYSTEMS

The general constitution of fused bicyclic hydrocarbon is given by :



$[l \geq m > 0]$

So, obviously the smallest member is :

Bicyclo [1.1.0] butane *i.e.*  ; here, $l = m = 1$. It is highly strained molecule and here the strain energy is 278 kJ mol^{-1} *i.e.* 66.5 kcal mol^{-1} and it is even greater than the sum of two separate cyclopropane rings. Each cyclopropane ring has a strain energy of 115 kJ mol^{-1} or 27.5 kcal mol^{-1}.

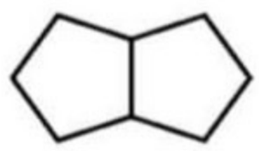
If you take the next homologue of this series then that is : Bicyclo [2.1.0] pentane. It has lesser strain that is 240 kJ mol^{-1} or 57.3 kcal mol^{-1}. Still this has also greater strain than the sum of the strains of cyclobutane which is 110 kJ mol^{-1} or 26.3 kcal mol^{-1}.

It is observed that for the higher bicyclo [*n*.1.0] alkanes [$n > 2$], the total strain in the molecule is nearly equal to the sum of the strains of component rings.

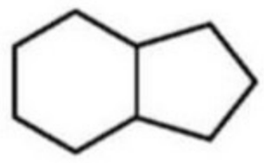
Geometrically, small rings are always fused in *cis*-orientation only. Small rings in these fused systems experience excess strain because extranuclear bonds are deviated and try to orient at smaller angles and additional angle strain is developed around the fused position.

Trans-oriented bonds are geometrically not allowed to be formed as they are not allowed to form the loop required for small ring formation.

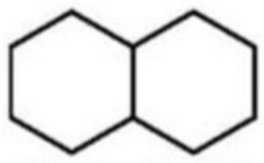
Thermally stable *cis* and *trans* isomers are known in fused systems with medium rings. For example :



Bicyclo [3.3.0] octane



Bicyclo [4.3.0] nonane or hydrindane

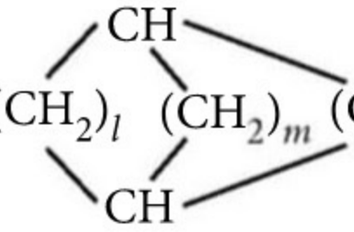


Bicyclo [4.4.0] decane or decalin.

In these systems the *trans*-isomer is generally more stable than *cis*-isomer at ambient temperature. With rise in temperature, the thermodynamic stability of the *cis*-isomer increases. The less stability of the cis isomer is accounted for greater extent of bond opposition or gauche interaction around the fused position.

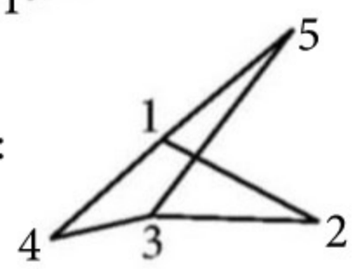
BRIDGE BICYCLES

General constitution here is :

Bridged Bicycles :  $(l \geq m \geq n > 0)$

Smallest member here is :

Bicyclo [1.1.1] pentane

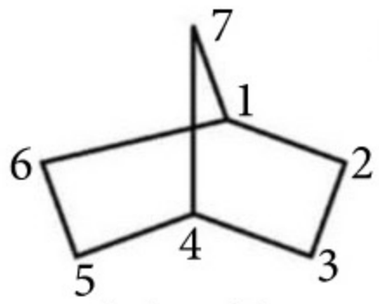


*Institute of Chemistry (IOC)- Asansol, Durgapur, Dhanbad, Burdwan, Kolkata, Jamshedpur, Bokaro, Patna

Strain energy here calculated to be around 250 to 284 kJ mol^{-1} or 60 to 68 kcal mol^{-1}. The distance between the transannular carbon atoms *i.e.*, C_1 and C_3 is from 1.84 Å to 1.87 Å. This value is the least distance ever observed between two non-bonded carbon atoms of any organic compound.

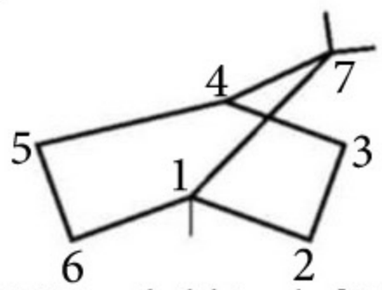
Some other bridged bicyclic compounds are :

(i)



Bicyclo [2.2.1] heptane or Norbornane

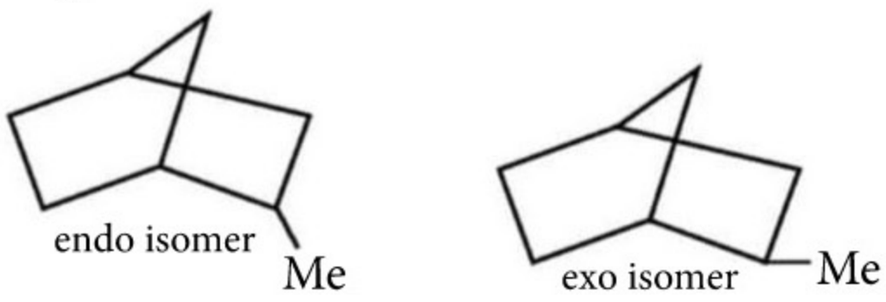
(ii)



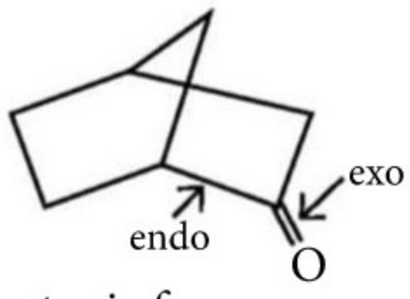
1, 7, 7-Trimethyl-bicyclo [2.2.1] heptane or Bornane

Observe Carefully!!

In both the above systems, the space within the cage formed by 2, 3, 5 and 6 positions is called as the ENDO site whereas the space outward this cage is known as EXO site. So, for 2-Methyl norbornane we have the following two isomers :

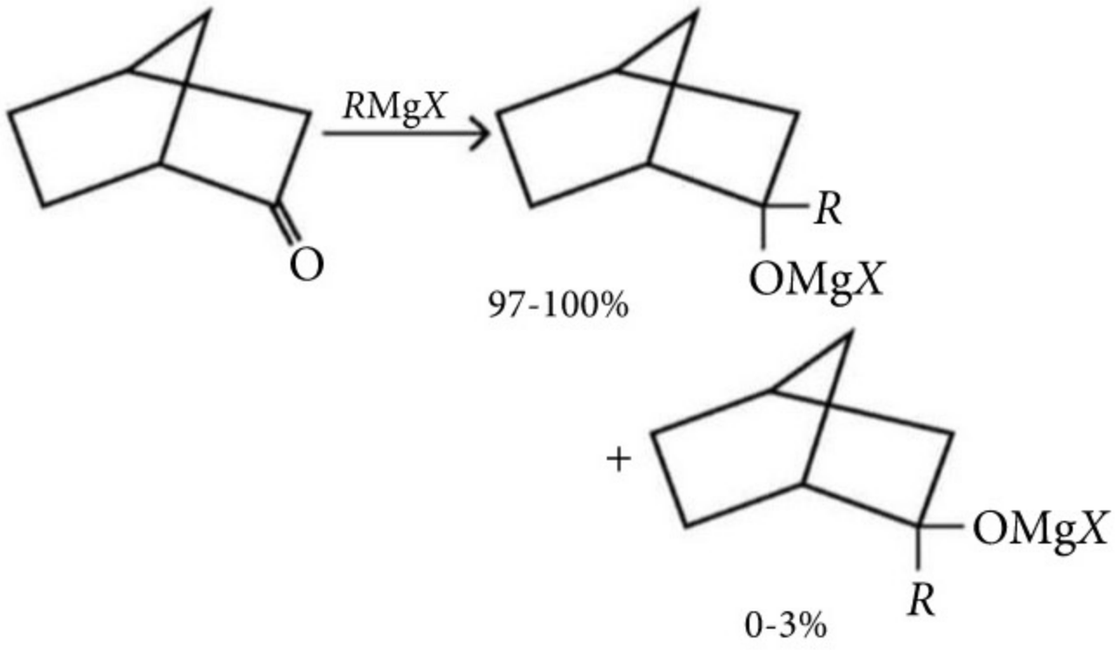


Similarly for Bicyclo [2.2.1] heptan-2-one we've

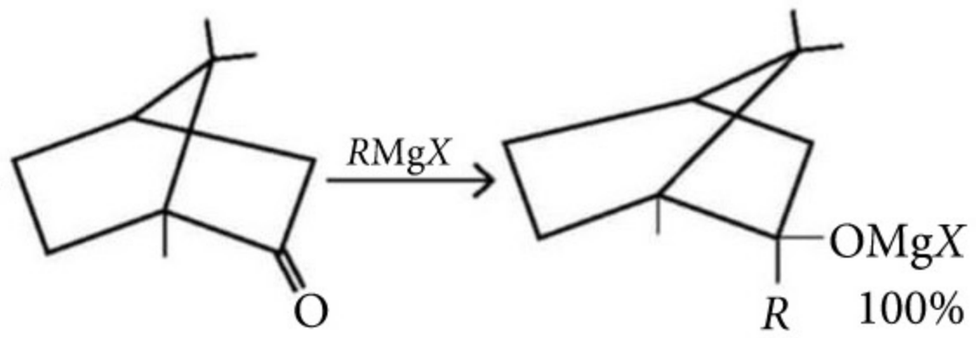


These are diastereotopic faces.

Now while a reaction has to take place *i.e.*, a reagent has to attack, then the approach of the reagent from the endo site (sterically hindered) is discouraged by endo H atoms or any substituents at C-3, C-5 and C-6 where the approach from the exo site is obstructed by any substituent at C-7. Take the following examples :



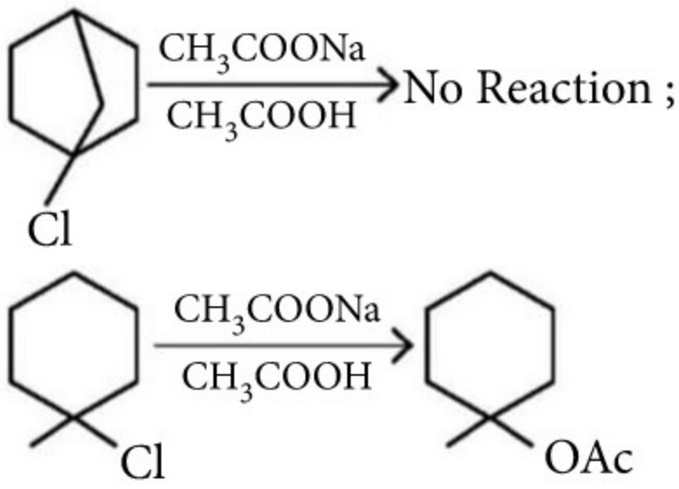
But,



BREDT'S RULE

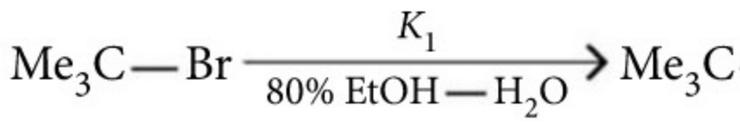
Rigid structures frame of bridged bicycles with small rings exert a special feature in the geometry of the molecule. The cyclic frame at the bridgehead position is essentially restricted to *cis* geometry.

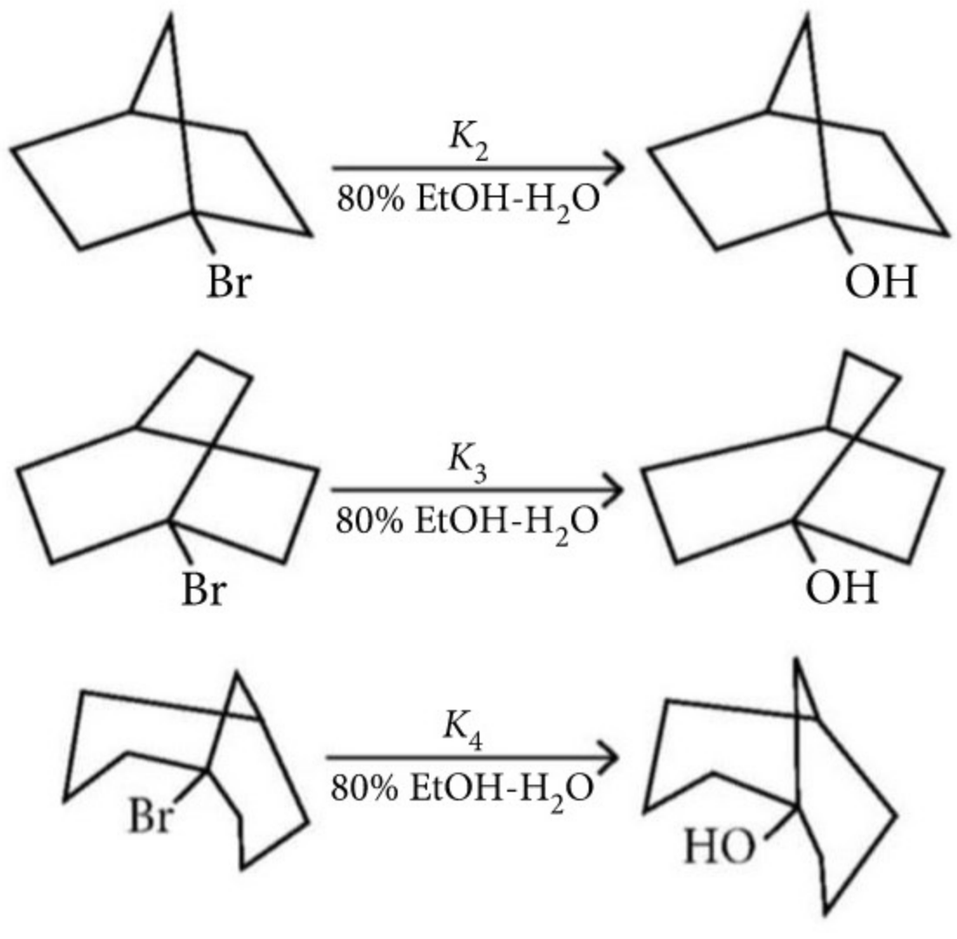
Another feature is cleavage of polarisable bond at the bridgehead position during reaction to form either carbocation or carbanion intermediate is not possible. The enforced pyramidal geometry of carbocation at the bridgehead position deviates from its ideal triangular planar geometry and therefore the potential energy of such carbocations becomes very high. Take the following most popular examples :

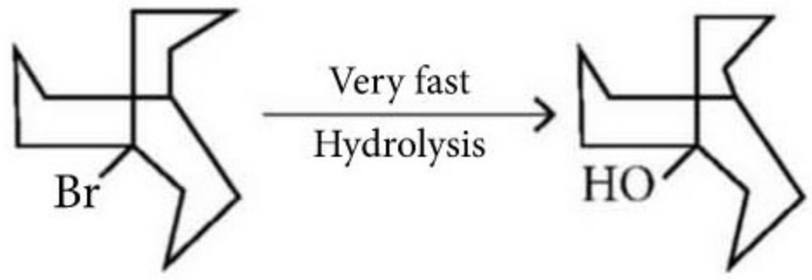


Very Rapid ($AC = CH_3-\overset{\overset{O}{\|}}{C}-$)

Again, look at the following comparative study :



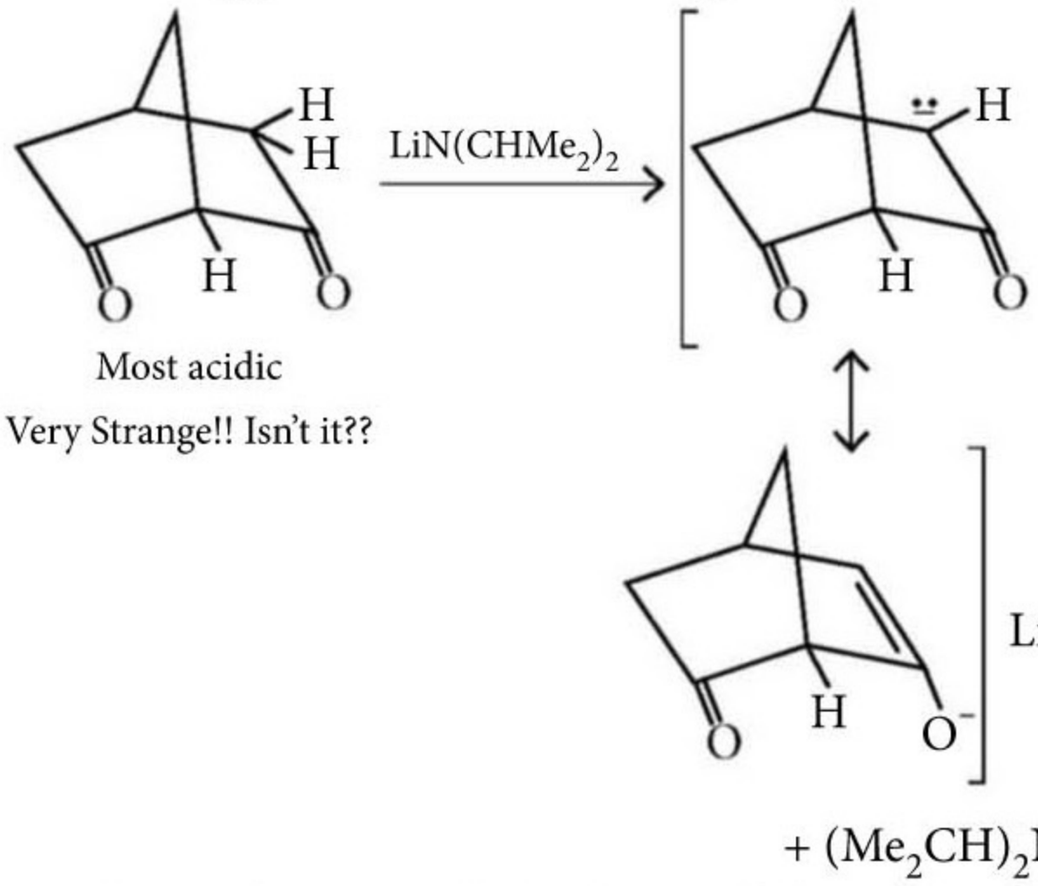




$K_1 : K_2 : K_3 : K_4 = 1 : 10^{-13} : 10^{-6} : 10^{-2}$

So far it was OK. But what is the problem in carbanion as carbanions have their ideal regular geometry as pyramidal geometry only? Actually, the negative charge at the bridgehead can't be dispersed by resonance even if there is any electron withdrawing group at the adjacent position. The non-bonding orbital on carbanion centre at the bridgehead position is now not parallel to the adjacent carbon atoms *p*-orbital.

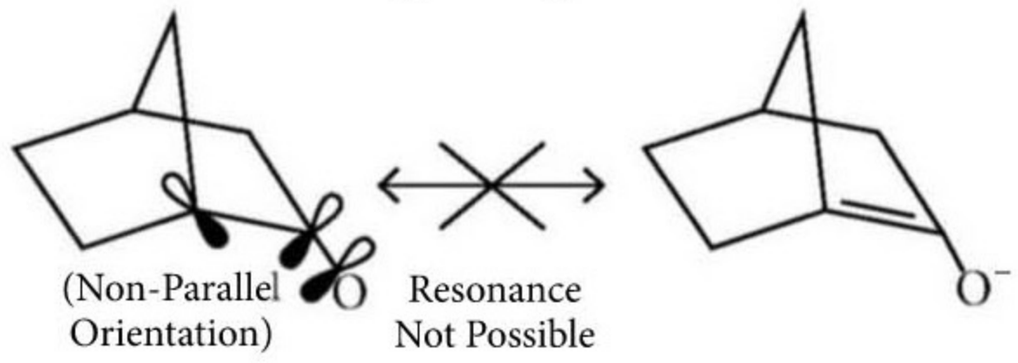
(Carbon atom of the electron withdrawing group). You can find support from the following example :



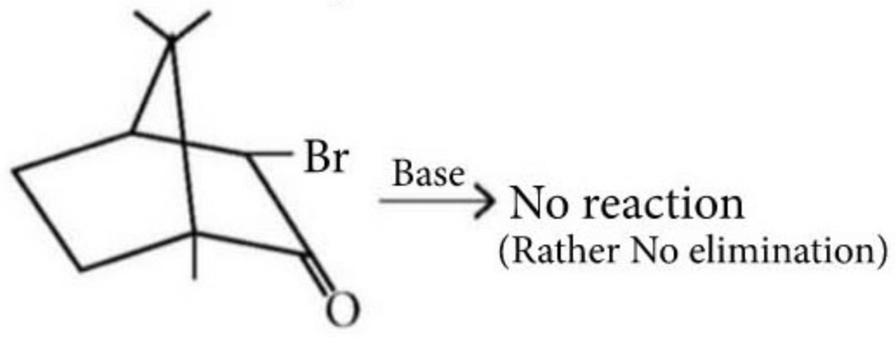
Most acidic

Very Strange!! Isn't it??

Expulsion of most acidic hydrogen did not take place here as it is at the bridgehead position.



Take a different example now



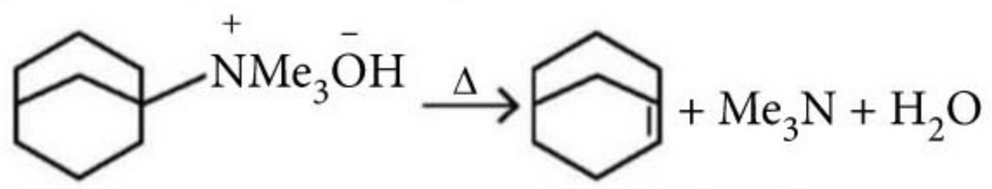
So, we can find another restriction in the structural feature of bridged unsaturated system offered by Bredt's rule. The rule states that for steric reason it is not possible to get a double bond at the bridgehead position. From many other similar types of observations, Bredt concluded that in small bi- and polycyclic ring systems a normal or usual double bond can't be formed at the bridgehead,

Now, a major question is, is there any way by which there can be stability in the bridgehead double bond ?? Yes it is!!

STABILITY OF BREDT'S OLEFINS (FAWCETT'S RULE)

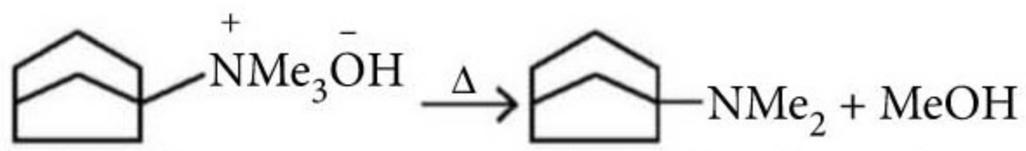
Bridged bi- and polycyclic systems with a double bond at the bridgehead position are commonly called as Bredt's olefins. Later on, an extensive review was given by Fawcett on Bredt;'s olefins and a generalised rule related to comparative stability of these systems was given. Suppose, there is a Bicyclo [*l.m.n*] system. Here, the sum, $S = l + m + n$ is predicted as the decisive parameter to decide or assign relative stabilities of Bredt's olefins. Larger the sum, greater is the stability of the system. At what time, a minimum sum of 9 was taken to be the criterion for thermally stability Bredt's olefins.

However, later on Bredt's olefin with a smaller value of S(= 7) was synthesised and isolated. Check the following popular comparative study :



[3.3.1] system
3 + 3 + 1 = 7

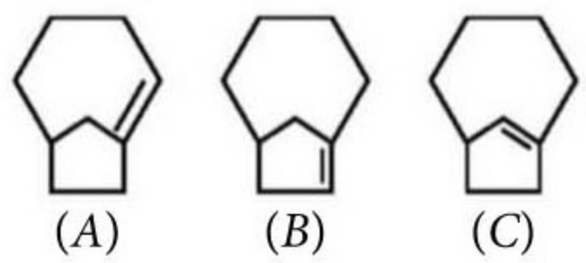
(application of sum Rule is successful here)



[3.2.1] system
3 + 2 + 1 = 6

(Application of sum rule is a big failure here)

But remember that the sum $S = l + m + n$ cannot be the only essential criterion to determine stability. Take the following three compounds :



(*A*) (*B*) (*C*)

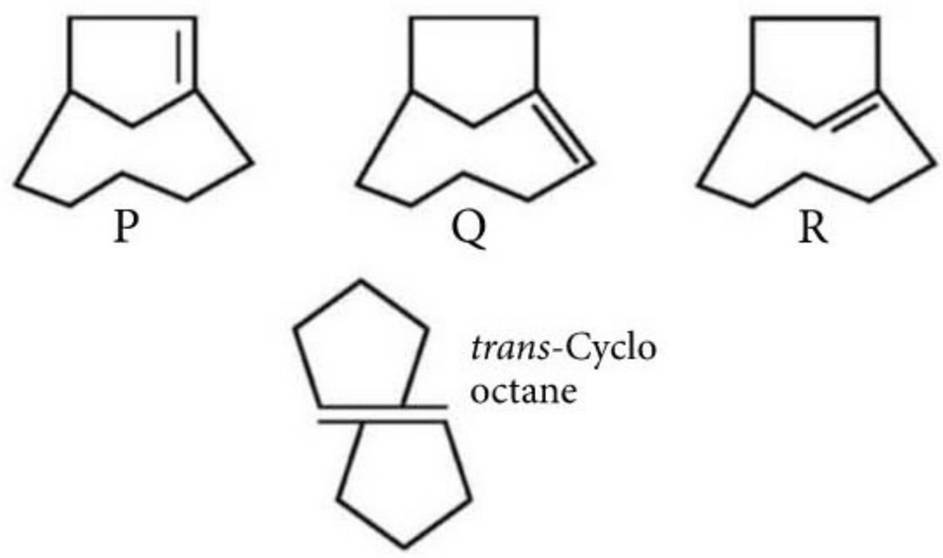
[In all cases sum *S* will be same]

Here *A* is more stable than *B* and remember that *C* is thermally so unstable that it cannot even be isolated.

Actually, *trans* geometrical requirement of the cyclic frame in these Bredt's olefins is more important than

the sum rule. From different observations, it has been established that the smallest cycloalkene that can adopt a trans geometry of the olefinic bond is cyclooctene. So, to accomodate the double bond in *trans* geometry the no. of ring atoms should be 8 at least. Further, a ring of small size with exocyclic double bound suffers less angle strain but a ring of small size with endocyclic double bond induces greater angle strain as two olefinic sp^2-hybrid carbon atoms reduce their normal valence angles of 120° to the requisite angle of small ring.

To have a crystal clear idea, see this :



Isomer	$S = l + m + n$	No. of ring atoms of the component ring with trans geometry of C=C (W)	No. of ring atoms of the component ring with cis geometry of C=C (X)	No. of ring atoms of the component ring with the exocyclic C=C (I)
P	8	9	5	8
Q	8	9	8	5
R	8	8	5	9

According to condition W, R is least stable. P is less stable than Q because condition X is smaller in P than Q. Overall stability order : $R > P > Q$.

CLASS-XII

BRUSH UP for NEET/JEE

Brush up your concepts to get high rank in NEET/JEE (Main and Advanced) by reading this column. This specially designed column is updated year after year by a panel of highly qualified teaching experts well-tuned to the requirements of these Entrance Tests.

2021

Unit 2

Electrochemistry| Chemical Kinetics | Surface Chemistry

Electrochemistry

- The study of production of electricity from energy released during spontaneous chemical reactions and the use of electrical energy to bring about non-spontaneous chemical transformations.
- The commercial production of a number of metals (like Na, Mg, Ca and Al) and chemicals (like NaOH, Cl_2, F_2), batteries and cells used in various instruments and the sensory signals sent to brain through the cells and vice versa and also the communication among different cells are based on electrochemical phenomena.

Conductance in Electrolytic Solutions

Conductance and Conductivity

Conductance $(G) = \frac{1}{R} = \frac{a}{\rho l}$

It increases with dilution as more number of ions are produced.

Conductivity $(\kappa) = G\frac{l}{a}$

It decreases with dilution as number of ions per cm^3 decreases.

Equivalent conductivity $(\Lambda_{eq}) = \kappa \times V = \kappa \times \frac{1000}{N}$

It increases with dilution due to increase in volume (V).

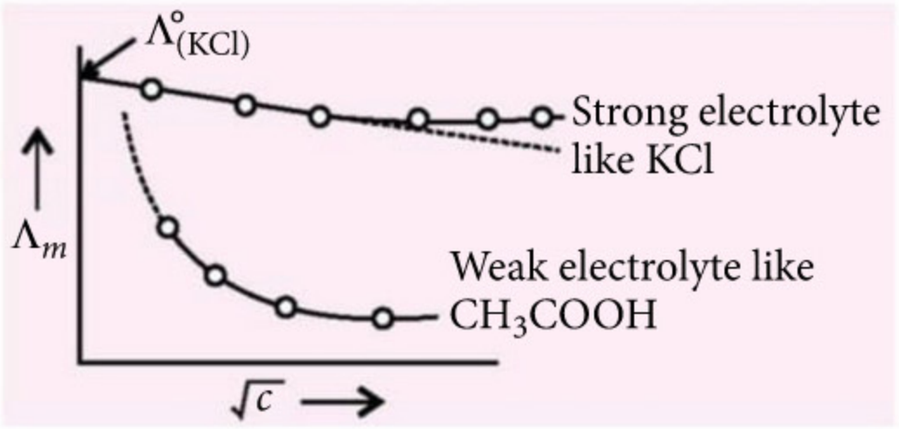
Molar conductivity $(\Lambda_m) = \kappa \times V = \kappa \times \frac{1000}{M}$

It increases with dilution due to increase in volume (V).

Variation of Molar Conductivity with Concentration

- For a strong electrolyte, Λ_m increases slowly with dilution which is shown by *Debye-Huckel Onsager equation* as follows :

$$\Lambda_m = \Lambda_m^\circ - A\sqrt{c}$$



Here, Λ_m° = Molar conductivity at infinite dilution (Limiting molar conductivity)

Λ_m = Molar conductivity at V-dilution

A = Constant which depends upon nature of solvent and temperature

c = Concentration

Kohlrausch's Law

- Equivalent conductivity at infinite dilution

$$\Lambda^\circ_{eq} = \lambda^\circ_{cation} + \lambda^\circ_{anion}$$

- Molar conductivity at infinite dilution,

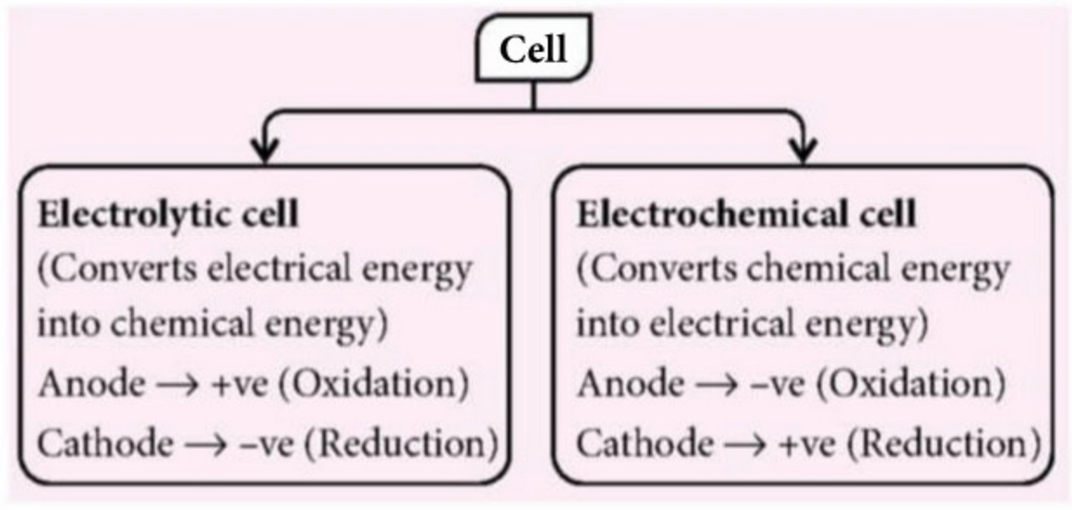
Λ_m° for $A_xB_y = x\lambda_+^\circ + y\lambda_-^\circ$

- It helps in calculation of molar conductivity (Λ_m°), degree of dissociation (α) and dissociation constant (K_c) of weak electrolytes.

$$\alpha = \frac{\Lambda_m^c}{\Lambda_m^\circ};\ K_c = \frac{c\alpha^2}{1-\alpha}$$

{For reaction, $AB \rightleftharpoons A^+ + B^-$}

Types of Cells



Cell Potential or EMF of a Cell

- $E^\circ_{cell} = E^\circ_{ox\ (anode)} + E^\circ_{red\ (cathode)}$
- $E^\circ_{cell} = E^\circ_{red\ (cathode)} - E^\circ_{red\ (anode)}$

$= E^\circ_{right} - E^\circ_{left}$

- $E^\circ_{cell} = E^\circ_{ox\ (anode)} - E^\circ_{ox\ (cathode)}$

Nernst Equation

- For electrode reaction,

$$M^{n+}_{(aq)} + ne^- \longrightarrow M_{(s)}$$

$$E_{M^{n+}/M} = E^\circ_{M^{n+}/M} - \frac{2.303RT}{nF}\log\frac{1}{[M^{n+}]}(\because [M] = 1)$$

$$= E^\circ_{M^{n+}/M} - \frac{0.0591}{n}\log\frac{1}{[M^{n+}]} \text{ at 298 K}$$

- For electrochemical reaction,

$$aA + bB \longrightarrow cC + dD$$

$$E_{cell} = E^\circ_{cell} - \frac{2.303RT}{nF}\log\frac{[C]^c[D]^d}{[A]^a[B]^b}$$

where, $E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$ and concentrations of pure solids are taken as unity.

- Equilibrium constant from Nernst equation,

At equilibrium, $E_{cell} = 0$ thus,

$$E^\circ_{cell} = \frac{2.303RT}{nF}\log K_c \text{ at 298 K}$$

Faraday's Laws of Electrolysis

Faraday's first law of electrolysis,

$w = Z \times I \times t$

where $Z = \dfrac{\text{Eq. wt. of substance}}{96500}$

Faraday's second law of electrolysis,

$$\frac{w_1}{w_2} = \frac{E_1}{E_2}$$

INFO SHOTS

Working of Lithium-ion batteries!

In a rechargeable lithium-ion, the positive electrode is typically made from a chemical compound called lithium-cobalt oxide ($LiCoO_2$) or, in newer batteries, from lithium iron phosphate ($LiFePO_4$). The negative electrode is generally made from carbon (graphite) and the electrolyte varies from one type of battery to another. When the battery is charging up, the lithium-cobalt oxide, positive electrode gives up some of its lithium ions, which move through the electrolyte to the negative, graphite electrode and remain there. The battery takes in and stores energy during this process. When the battery is discharging, the lithium ions move back across the electrolyte to the positive electrode, producing the energy that powers the battery. In both cases, electrons flow in the opposite direction to the ions around the outer circuit.

Chemical Kinetics

The branch of chemistry which deals with the study of the speeds or the rates of chemical reactions, the factors affecting the rates of the reactions and the mechanism by which the reactions proceed.

Rate of Chemical Reaction

For reaction, $A \rightarrow B$

$$\text{Rate of reaction} = -\frac{\Delta[A]}{\Delta t} = +\frac{\Delta[B]}{\Delta t}$$

$$\text{Instantaneous rate} = -\frac{d[A]}{dt} = +\frac{d[B]}{dt}$$

$$\text{Average rate of reaction} = -\frac{\Delta[A]}{\Delta t} = +\frac{\Delta[B]}{\Delta t}$$

Factors Affecting Rate of Reaction

Size of solid reactant decreases, rate of reaction increases.

Gaseous state > Liquid state > Solid state

Decreasing rate of reaction

Rate of reaction ∝ Temperature

Rate of reaction ∝ Concentration of reactant

A positive catalyst increases while negative catalyst decreases the rate of reaction by altering the reaction pathway and activation energy.

Types of Reactions

Elementary reactions : Single step reaction with no detectable intermediate.

Complex reaction : Involves more than one elementary reactions.

Molecularity and Order of a Reaction

- **Molecularity of a reaction :** It is the total number of species taking part in an elementary reaction and its value is a whole number only.
- **Order of a reaction :** It is the sum of the powers of the concentration terms of reacting species in the rate law expression and its value may be zero, fractional or an integer.

Rate Law, Integrated Rate Law, Half-Life, Unit of Rate Constant and Graph for the Reactions of Different Orders

Order	Rate law	Integrated rate law	Half-life	Unit of rate constant	Graph
0	Rate = $k[A]^0$	$[A]_t = -kt + [A]_0$	$t_{1/2} = [A]_0/2k$	mol L^{-1} s^{-1}	$[A]$ *vs* t; slope = $-k$
1	Rate = $k[A]^1$	$\ln[A]_t = -kt + \ln [A]_0$	$t_{1/2} = 0.693/k$	s^{-1}	$\ln[A]$ *vs* t; slope = $-k$
2	Rate = $k[A]^2$	$1/[A]_t = kt + 1/[A]_0$	$t_{1/2} = 1/k\,[A]_0$	L mol^{-1} s^{-1}	$1/[A]$ *vs* t; slope = k
2	Rate = $k[A]\,[B]$	$kt = \frac{1}{[A]_0 - [B]_0} \ln \frac{[B]_0[A]}{[A]_0[B]}$	–	L mol^{-1} s^{-1}	$1/[A]$ *vs* t; slope = k
n	Rate = $k[A]^n$	$(n-1)kt = \frac{1}{[A]^{n-1}} - \frac{1}{[A_0]^{n-1}}$	$t_{1/2} = \frac{2^{n-1}-1}{k(n-1)[A]_0^{n-1}}$	(mol L^{-1} $)^{1-n}$ s^{-1}	$\frac{1}{[A]^{n-1}}$ *vs* t; slope = k

Arrhenius Equation

- $k = Ae^{-E_a/RT}$ or $\log k = \log A - \frac{E_a}{2.303RT}$
- For a reaction, at two different temperatures

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{T_2 - T_1}{T_1T_2}\right]$$

where, k_1 and k_2 are the values of rate constant at temperatures T_1 and T_2 respectively.

Collision Theory

- Reactions occur only when molecules collide with appropriate orientation and sufficient energy ($E > E_a$). Rate = $PZ_{AB}e^{-E_a/RT}$ where, P = probability or steric factor which takes into account the fact that in a collision, molecules must be properly oriented and Z_{AB} = collision frequency (*i.e.*, the no. of collisions per second per unit volume of the reaction mixture) of reactants, A and B.

INFO SHOTS

Pharmacokinetic Parameters of Elimination

Pharmacokinetic studies the manner and speed with which drugs and their metabolites are eliminated by the various excretory organs.

Zero-order elimination kinetics : "Elimination of a constant quantity per unit time of the drug quantity present in the organism". The elimination is independent of the drug concentration in the body.

First order elimination kinetics : "Elimination of a constant fraction per unit time of the drug quantity present in the organism. The elimination is proportional to the drug concentration". 95% of the drugs in use at therapeutic concentrations are eliminated by first order elimination kinetics. A few substances are eliminated by zero-order elimination kinetics, because their elimination process is saturated. Examples are ethanol, phenytoin, salicylates, cisplatin, fluxetin, omeprazol.

Surface Chemistry

Adsorption

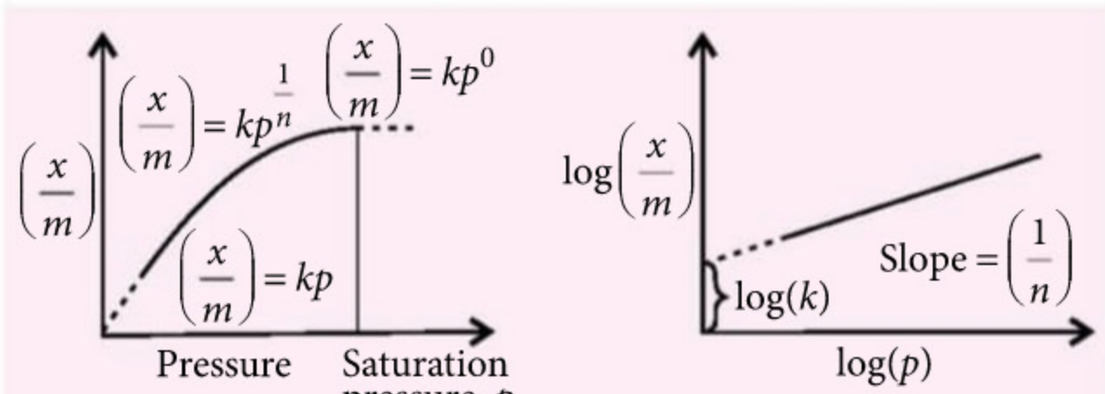
- *Adsorption* is the phenomenon of existence of higher concentration of any particular component (*adsorbate*) at the surface of liquid or solid phase (*adsorbent*) than in the bulk.

- **Physisorption and Chemisorption**

Physisorption	Chemisorption
Molecules are held by weak van der Waals' forces and it is reversible in nature.	Molecules are held by chemical bonds and it is irreversible in nature.
More easily liquefiable gases are adsorbed readily.	Gases which can react with the adsorbent show chemisorption.
Enthalpy of adsorption is low (20 - 40 kJ mol^{-1})	Enthalpy of adsorption is high (80 - 240 kJ mol^{-1})
Low temperature and large surface area are favourable.	High temperature and large surface area are favourable.
Forms multimolecular layer.	Forms unimolecular layer.

Adsorption Isotherms

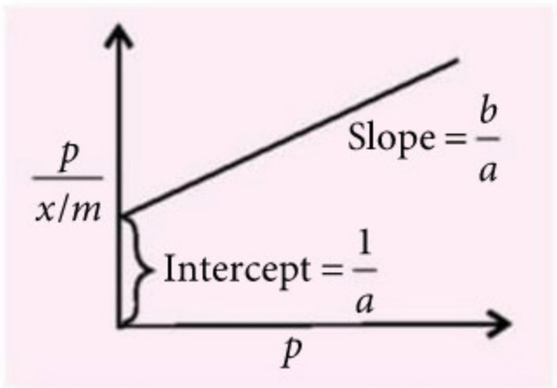
- **Freundlich adsorption isotherm :** It is the plot of $\frac{x\ (\text{mass of adsorbent})}{m\ (\text{mass of adsorbate})}$ *vs* pressure at constant temperature.



  - For low pressure, $\frac{x}{m} \propto p$
  - For high pressure, $\frac{x}{m} \propto p^0$
  - For intermediate pressure, $\frac{x}{m} \propto p^{1/n} (n > 1)$

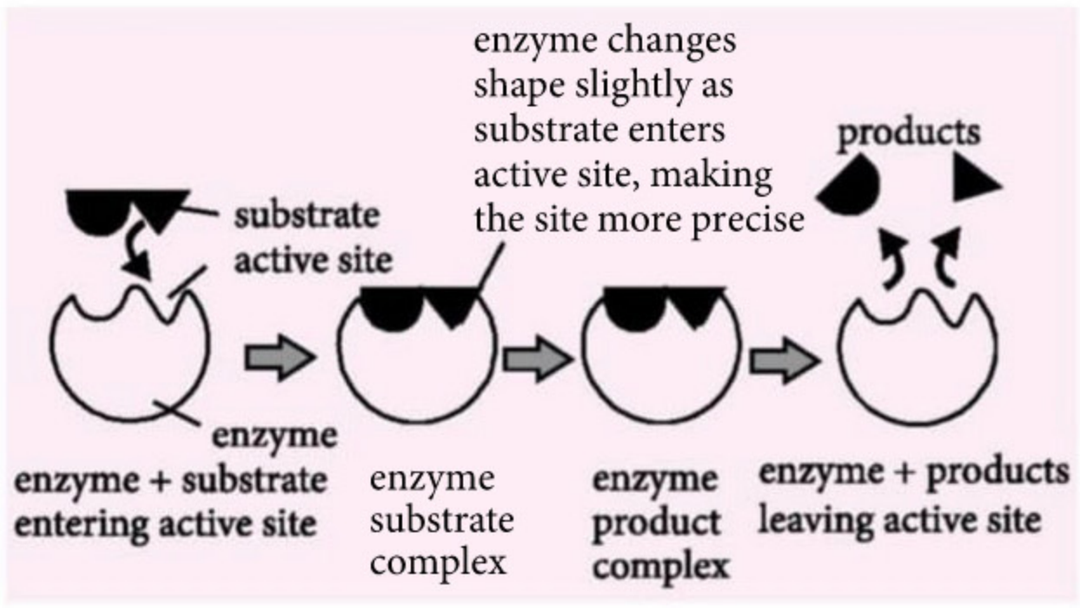
  $$\log \frac{x}{m} = \log k + \frac{1}{n} \log p$$

- **Langmuir adsorption isotherm :** Applicable for monolayer adsorption, $\frac{x}{m} = \frac{ap}{1+bp}$ where, a and b are constants whose values depend upon the nature of the gas adsorbed, nature of the adsorbent and temperature.



Catalysis

- *Catalysis* is the process of enhancing the rate of a reaction by a catalyst. The ability of catalysts to catalyse a particular reaction only is called *selectivity of catalysts*.
  - **Homogeneous catalysis :** The process in which the reactants and the catalyst are in the same phase.
  - **Heterogeneous catalysis :** The process in which the reactants and the catalyst are in different phases.
- **Enzyme catalysis :** Process of catalysing all biological reactions by special catalyst called enzymes (or biochemical catalysts). Chemically, all enzymes are globular proteins.



Colloids, True Solutions and Suspensions

True Solutions
- Size of particles is < 1 nm.
- Separation is not possible by filter paper or parchment membrane.
- It is transparent and homogenous.

Colloids
- Size of particles is 1 - 1000 nm.
- Separation is possible with parchment membrane.
- It is transluscent and heterogenous.

Suspensions
- Size of particles is > 1000 nm.
- Separation can be done even with filter paper.
- It is opaque and heterogenous.

Multimolecular colloids

Colloidal particles are aggregates of molecules *e.g.*, S_8, gold etc.

Macromolecular colloids

Colloidal particles are macromolecules *e.g.*, starch, cellulose, protein, etc.

Associated colloids (Micelles)

Ions aggregate to form micelles. *e.g.*, soaps and detergents.

Lyophilic colloids

Reversible sols, quite stable

Lyophobic colloids

Irreversible sols, not stable

Properties of Colloids

- **Colligative properties** - Values are very low due to aggregation.
- **Brownian movement** - Zig-zag movement of particles that stabilise colloidal sols.
- **Electrophoresis** - Movement of colloidal particles towards opposite charged electrode under the influence of electric field. Different colloidal particles have different mobilities using this property mixture of colloids can be separated.
- **Tyndall effect** - Scattering of light by colloidal particles.
- **Electrical properties** - All dispersed particles of sol have same charge so, they repel each other and stabilise colloidal sol.
- **Coagulation** - Precipitation of colloidal sol by the addition of electrolyte.

Protective Power and Coagulating Power

- *Gold number* is the minimum mass (in milligrams) of the protective colloid which must be added to 10 mL of a standard red gold sol to prevent the coagulation when 1 mL of 10% solution of NaCl is added to it.
- Protective power $\propto \frac{1}{\text{Gold number}}$
- Greater the valency of coagulating ion of the electrolyte, faster is the coagulation (*Hardy-Schulze Rule*).
  - Flocculation value $\propto \frac{1}{\text{Coagulating power}}$

Emulsions

- Colloidal system is which both the dispersed phase and dispersion medium are liquids is called emulsion.
  - Oil in water type : Oil is dispersed phase and water is dispersion medium *e.g.*, milk, body lotion, etc.
  - Water in oil type : Water is dispersed phase and oil is dispersion medium *e.g.*, butter, cold cream, etc.
  - Emulsification : Process of making an emulsion.
  - Emulsifying agent : Used to stabilize the emulsion *e.g.*, soaps and detergents.
  - Demulsification : Separating the two components of an emulsion. Methods used are boiling, freezing, changing pH.

Applications of Surface Chemistry

The Nobel Prize in Chemistry for 2007 was awarded to Gerhard Ertl for his studies of chemical processes in solid surfaces. Surface chemistry, a science that is really important for the chemical industry. It improves understanding of a variety of processes, including iron rusting, fuel cells functioning and working of the catalysts in our cars. Chemical reactions on catalytic surfaces are really important for a lot of industrial operations, inducing the production of artificial fertilizers. Surface chemistry can even provide explanation of the ozone layer destruction, with vital steps in the reaction taking place on the surfaces of small crystals of ice in the stratosphere. The semiconductor industry also greatly depends on knowledge of surface chemistry.

INFO SHOTS

WRAP it up!

1. The quantity of electricity required to liberate 112 cm^3 of hydrogen at STP from acidified water is
(a) 0.1 faraday (b) 96500 coulomb
(c) 965 coulomb (d) 10 faraday.

2. Addition of lyophilic sols. to lyophobic colloid, forms
(a) a protective film around the dispersed phase
(b) a protective film around the dispersion medium
(c) an aerosol
(d) true solution.

3. For the following electrochemical cell at 298 K,
$Pt_{(s)}|H_{2(g)}, (1\ bar)|H^+_{(aq)}, (1\ M)||M^{4+}_{(aq)}, M^{2+}_{(aq)}|Pt_{(s)}$

$E_{cell} = 0.092$ V when $\frac{[M^{2+}_{(aq)}]}{[M^{4+}_{(aq)}]} = 10^x$

Given : $E^\circ_{M^{4+}/M^{2+}} = 0.151$ V; $2.303\frac{RT}{F} = 0.059$ V

The value of x is
(a) –2 (b) –1
(c) 1 (d) 2 **(JEE Advanced 2016)**

4. The coagulation of 10 mL of a colloidal sol of gold is completely prevented by addition of 0.25 g of a substance X to it before adding 1 mL of 10% NaCl solution. The gold number of X is
(a) 25 (b) 0.25
(c) 2.5 (d) 250

5. A cell is containing two H electrodes. The negative electrode is in contact with a solution of 10^{-6} M H^+ ions. The e.m.f. of the cell is 0.118 V at 25°C. What is the $[H^+]$ at positive electrode?
(a) 10^{-4} M (b) 10^{-6} M
(c) 10^{-2} M (d) 10^{-8} M

6. The addition of a catalyst during a chemical reaction alters which of the following quantities?
(a) Enthalpy (b) Activation energy
(c) Entropy (d) Internal energy
(NEET 2016)

7. Faraday's laws of electrolysis will fail when
(a) temperature is increased
(b) inert electrodes are used
(c) a mixture of electrolytes is used
(d) in none of these cases.

8. Given that the standard potentials ($E°$) of Cu^{2+}/Cu and Cu^+/Cu are 0.34 V and 0.522 V respectively, the $E°$ of Cu^{2+}/Cu^+ is
(a) – 0.182 V (b) + 0.158 V
(c) – 0.158 V (d) 0.182 V.
(JEE Main 2020)

9. Bleeding is stopped by the application of ferric chloride. This is because
(a) the blood starts flowing in the opposite direction
(b) the blood reacts and a solid is formed which seals the blood vessel
(c) the blood is coagulated and the blood vessels are sealed
(d) the ferric chloride seals the blood vessel.

10. Which property of colloidal solution is independent of charge on the colloidal particles?
(a) Electro-osmosis (b) Tyndall effect
(c) Coagulation (d) Electrophoresis
(AIPMT 2015)

11. For the elementary reaction $M \rightarrow N$, the rate of disappearance of M increases by a factor of 8 upon doubling the concentration of M. The order of the reaction with respect to M is
(a) 4 (b) 3
(c) 2 (d) 1 **(JEE Advanced 2014)**

12. A hypothetical reaction, $A_2 + B_2 \longrightarrow 2AB$ follows the mechanism as given below;
$A_2 \rightleftharpoons A + A$ .....(fast)
$A + B_2 \longrightarrow AB + B$ .....(slow)
$A + B \longrightarrow AB$ .....(fast)
The order of the overall reaction is
(a) 2 (b) 1
(c) $1\frac{1}{2}$ (d) zero.

13. Higher order (>3) reactions are rare due to
(a) shifting of equilibrium towards reactants due to elastic collisions
(b) loss of active species on collision
(c) low probability of simultaneous collision of all the reacting species

(d) increase in entropy and activation energy as more molecules are involved.

(JEE Main 2015)

14. Which one of the following characteristics is associated with adsorption?

(a) ΔG and ΔH are negative but ΔS is positive.

(b) ΔG and ΔS are negative but ΔH is positive.

(c) ΔG is negative but ΔH and ΔS are positive.

(d) ΔG, ΔH and ΔS all are negative. **(NEET 2016)**

15. A student made the following observations in the laboratory :

(i) Clean copper metal did not react with 1 molar $Pb(NO_3)_2$ solution.

(ii) Clean lead metal dissolved in a 1 molar $AgNO_3$ solution and crystals of Ag metal appeared.

(iii) Clean silver metal did not react with 1 molar $Cu(NO_3)_2$ solution.

The order of decreasing reducing character of the three metals is

(a) Cu, Pb, Ag (b) Cu, Ag, Pb

(c) Pb, Cu, Ag (d) Pb, Ag, Cu

16. For the reaction,

$2H_{2(g)} + 2NO_{(g)} \rightarrow N_{2(g)} + 2H_2O_{(g)}$

the observed rate expression is, rate $= k_f [NO]^2 [H_2]$. The rate expression for the reverse reaction is

(a) $k_b[N_2][H_2O]^2/[H_2]$ (b) $k_b[N_2]\,[H_2O]$

(c) $k_b[N_2]\,[H_2O]^2$ (d) $k_b[N_2]\,[H_2O]^2/[NO]$

(JEE Main 2020)

17. A first order reaction has a rate constant of $2.303 \times 10^{-3}\ s^{-1}$. The time required for 40 g of this reactant to reduce to 10 g will be

[Given that $\log_{10} 2 = 0.3010$]

(a) 230.3 s (b) 301 s

(c) 2000 s (d) 602 s

(Odisha NEET 2019)

18. Given below are the half-cell reactions :

$Mn^{2+} + 2e^- \longrightarrow Mn;\ E^\circ = -1.18\ V$

$2(Mn^{3+} + e^- \longrightarrow Mn^{2+});\ E^\circ = +1.51\ V$

The E° for $3Mn^{2+} \longrightarrow Mn + 2Mn^{3+}$ will be

(a) – 0.33 V; the reaction will occur

(b) – 2.69 V; the reaction will not occur

(c) – 2.69 V; the reaction will occur

(d) – 0.33 V; the reaction will not occur.

(JEE Main 2014)

19. For the reaction,

$[Cu(NH_3)_4]^{2+} + H_2O \rightleftharpoons [Cu(NH_3)_3H_2O]^{2+} + NH_3$

the net rate of reaction at any time is given by :

Net rate $= 2.0 \times 10^{-4}\,[[Cu(NH_3)_4]^{2+}] - 3.0 \times 10^{5}\,[[Cu(NH_3)_3H_2O]^{2+}][NH_3]$

Then correct statement is (are)

(a) rate constant for forward reaction $= 2 \times 10^{-4}$

(b) rate constant for backward reaction $= 3 \times 10^{5}$

(c) equilibrium constant for the reaction $= 6.6 \times 10^{-10}$

(d) all of these.

20. The pressure of H_2 required to make the potential of H_2-electrode zero in pure water at 298 K is

(a) 10^{-10} atm (b) 10^{-4} atm

(c) 10^{-14} atm (d) 10^{-12} atm **(NEET 2016)**

21. A galvanic cell is constructed as follows. A half-cell consists of a platinum wire immersed in a solution containing 1.0 M of Sn^{2+} and 1.0 M of Sn^{4+}, and another half-cell has a thallium rod immersed in a 1.0 M solution of Tl^+.

Given : $Sn^{4+}_{(aq)} + 2e^- \longrightarrow Sn^{2+}_{(aq)}$; $E^\circ = +0.13$ V

and $Tl^+_{(aq)} + e^- \longrightarrow Tl_{(s)}$; $E^\circ = -0.34$ V,

What is the cell voltage if the Tl^+ concentration is increased tenfold?

(a) 0.411 V (b) 4.101 V

(c) 0.492 V (d) 0.222 V

22. The equivalent conductance of NaCl at concentration C and at infinite dilution are λ_C and λ_∞, respectively. The correct relationship between λ_C and λ_∞ is given as (where, the constant B is positive)

(a) $\lambda_C = \lambda_\infty + (B)\sqrt{C}$ (b) $\lambda_C = \lambda_\infty + (B)C$

(c) $\lambda_C = \lambda_\infty - (B)C$ (d) $\lambda_C = \lambda_\infty - (B)\sqrt{C}$

(JEE Main 2014)

23. In a second order reaction, when the concentration of both the reactants are equal, the reaction is completed 20% in 500 s. How long would it take for the reaction to go to 60% completion?

(a) 3000 s (b) 5000 s

(c) 1000 s (d) 2000 s

24. When 0.1 mol MnO_4^{2-} is oxidised the quantity of electricity required to completely oxidise MnO_4^{2-} is

(a) 69500 C (b) 2×96500 C

(c) 9650 C (d) 96.50 C **(AIPMT 2014)**

25. Resistance of 0.2 M solution of an electrolyte is 50 Ω. The specific conductance of the solution is 1.4 S m^{-1}. The resistance of 0.5 M solution of the same electrolyte is 280 Ω. The molar conductivity of 0.5 M solution of the electrolyte in S m^2 mol^{-1} is

(a) 5×10^2 (b) 5×10^{-4}

(c) 5×10^{-3} (d) 5×10^3

(JEE Main 2014)

26. Consider the following reactions at 300 K.

$A \longrightarrow B$ (uncatalysed reaction)

$A \xrightarrow{\text{catalyst}} B$ (catalysed reaction)

The activation energy is lowered by 8.314 kJ mol^{-1} for the catalysed reaction. The rate of this reaction is

(a) 15 times (b) 38 times

(c) 22 times (d) 28 times.

27. On which of the following properties does the coagulating power of an ion depend?

(a) The magnitude of the charge on the ion alone

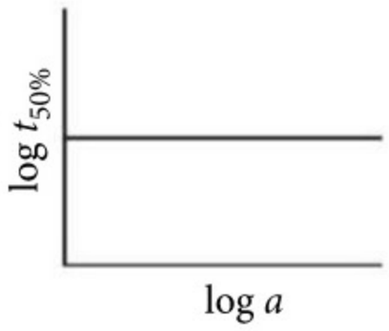
(b) Size of the ion alone

(c) Both magnitude and sign of the charge on the ion

(d) The sign of charge on the ion alone

(NEET 2018)

28. A graph plotted between log $t_{50\%}$ *vs* log concentration is a straight line. What conclusion can you draw from this graph?



(a) $n = 1; t_{1/2} = \dfrac{1}{x \times a}$ (b) $n = 2; t_{1/2} = \dfrac{1}{a}$

(c) $n = 1; t_{1/2} = \dfrac{0.693}{k}$ (d) None of these

29. According to Langmuir adsorption isotherm the amount of gas adsorbed at very high pressure

(a) reaches a constant limiting value

(b) goes on increasing with pressure

(c) goes on decreasing with pressure

(d) increases first and decreases later with pressure.

30. Which of the following is correct?

(a) Total collision rate $\propto$ mean speed $\propto$ absolute temperature

(b) Total collision rate $\propto \dfrac{1}{\text{mean speed}} \propto \dfrac{1}{\text{absolute temperature}}$

(c) Total collision rate $\propto$ mean speed $\propto$ (absolute temperature)$^{1/2}$

(d) Total collision rate $\propto$ (mean speed)^2 $\propto$ (absolute temperature)^3

SOLUTIONS

1. (c) : $H_2O \longrightarrow 2H^+ + O^{2-}$

At cathode : $2H^+ + 2e^- \longrightarrow H_2$

22,400 cm^3 of H_2 is released from = 2×96500 C

$\therefore$ 112 cm^3 of H_2 is released from

$= \dfrac{2 \times 96500}{22400} \times 112 = 965$ C

2. (a)

3. (d): At anode : $H_{2(g)} \rightarrow 2H^+_{(aq)} + 2e^-$

At cathode : $M^{4+}_{(aq)} + 2e^- \rightarrow M^{2+}_{(aq)}$

$H_{2(g)} + M^{4+}_{(aq)} \rightarrow M^{2+}_{(aq)} + 2H^+_{(aq)}$

$$E_{cell} = E^\circ_{cell} - \frac{0.059}{2} \log \frac{[M^{2+}][H^+]^2}{[M^{4+}]}$$

$$0.092 = \left(E^\circ_{M^{4+}/M^{2+}} - E^\circ_{H^+/H_2}\right) - \frac{0.059}{2} \log(10^x [H^+]^2)$$

$$0.092 = (0.151 - 0) - \frac{0.059}{2} \log (10^x \times 1^2)$$

$0.092 = 0.151 - 0.0295 \log 10^x$

$0.0295 \log 10^x = 0.151 - 0.092$

$$\log 10^x = \frac{0.059}{0.0295} = 2$$

$10^x = \text{Antilog } 2 = 10^2 \therefore \ x = 2$

4. (d): 0.25 g = 250 mg

5. (a) : At anode : $H \longrightarrow H^+ + e^-$

At cathode : $H^+ + e^- \longrightarrow H$

Given that, $E_{cell} = 0.118$ V; $[H^+]_{anode} = 10^{-6}$ M

$E^\circ_{cell(H^+/H)} = 0; n = 1$

We know, $$E_{cell} = E^\circ_{cell} - \frac{0.059}{n} \log \frac{[H^+]_{Anode}}{[H^+]_{Cathode}}$$

$\therefore$ $$0.118 = 0 - \frac{0.059}{1} \log \frac{10^{-6}}{[H^+]_{Cathode}}$$

or $$\log \frac{10^{-6}}{[H^+]_{Cathode}} = -2 \Rightarrow \frac{10^{-6}}{[H^+]_{Cathode}} = 10^{-2}$$

or $$[H^+]_{Cathode} = \frac{10^{-6}}{10^{-2}} = 10^{-4} \text{ M}$$

6. (b): A catalyst provides an alternate path to the reaction which has lower activation energy.

7. (d)

8. (b): $Cu^{2+} + e^- \longrightarrow Cu^+$;

$$\Delta G_1 = -nFE_1^\circ = -1 \times F \times E_1^\circ$$

$Cu^+ + e^- \longrightarrow Cu$; $\Delta G_2 = -1 \times F \times 0.522$

$Cu^{2+} + 2e^- \longrightarrow Cu$; $\Delta G_3 = -2 \times F \times 0.34$

Now, $\Delta G_3 = \Delta G_1 + \Delta G_2$

$-2 \times F \times 0.34 = -FE_1^\circ - 0.522F$

$E_1^\circ = +0.158$ V

9. (c): Fe^{3+} ion coagulates negative sol particles of blood and seals the cut.

10. (b): Tyndall effect is scattering of light by colloidal particles which is independent of charge on them.

11. (b): $M \rightarrow N$

$r = k[M]^x$ ...(i)

$8r = k[2M]^x$ ...(ii)

On dividing eqn. (ii) by (i), we get

$$8 = (2)^x \Rightarrow (2)^3 = (2)^x \Rightarrow x = 3$$

12. (c): For slow step,

$$r = k[A][B_2]$$

and $$K_c = \frac{[A][A]}{[A_2]} \text{ or } [A] = K_c^{1/2}[A_2]^{1/2}$$

Thus, $$r = k \cdot K_c^{1/2}[A_2]^{1/2}[B_2]$$

$$= k_1[A_2]^{1/2}[B_2] \qquad \{k_1 = k \cdot K_c^{1/2}\}$$

Hence, order is $\frac{3}{2}$.

13. (c): The reactions of higher order are very rare because of the less chances of the molecules to come together simultaneously and collide.

14. (d): As the molecules of the adsorbate are held on the surface of the solid adsorbent, entropy decreases *i.e.*, ΔS = –ve.

As $\Delta G = \Delta H - T\Delta S$

For the adsorption to occur, ΔG = –ve and it is possible only if ΔH = –ve.

15. (c): From observations (i), (ii) and (iii), reducing character of metals are Pb > Cu, Pb > Ag and Cu > Ag. Hence, for the three metals it is Pb > Cu > Ag.

16. (a): For the reaction,

$2H_{2(g)} + 2NO_{(g)} \rightarrow N_{2(g)} + 2H_2O_{(g)}$

$$\text{Rate} = k_f[NO]^2[H_2]$$

Thus, 2 NO and 1 H_2 get reacted and 1H_2 will be left on the reactant side so, the rate for the reverse reaction will be

$$\text{Rate} = \frac{k_b[N_2][H_2O]^2}{[H_2]}$$

17. (d): For a first order reaction, $k = \frac{2.303}{t}\log\frac{[A]_0}{[A]_t}$

$$2.303 \times 10^{-3} = \frac{2.303}{t}\log\frac{40}{10}$$

$$t = \frac{1}{10^{-3}}\log 2^2 = \frac{2}{10^{-3}}\log 2 = \frac{2}{10^{-3}} \times 0.3010 = 602 \text{ s}$$

18. (b): Overall reaction :

$Mn^{2+} + 2e^- \longrightarrow Mn$; $E^\circ = -1.18$ V

$2Mn^{2+} \longrightarrow 2Mn^{3+} + 2e^-$; $E^\circ = -1.51$ V

$3Mn^{2+} \longrightarrow Mn + 2Mn^{3+}$; $E^\circ = -1.18 + (-1.51)$

$= -2.69$ V

As E° is negative, the reaction will not occur.

19. (d): Net rate of reaction = rate of forward reaction – rate of backward reaction

$= K_f$[reactant] – K_b[product]

On comparing this relation with given equation, we get, $K_f = 2.0 \times 10^{-4}$, $K_b = 3.0 \times 10^5$

Also, $K_c = \frac{K_f}{K_b}$ at equilibrium

$$K_c = \frac{2\times10^{-4}}{3\times10^5} = 6.6 \times 10^{-10}$$

20. (c): pH = 7 for water.

$-\log[H^+] = 7 \Rightarrow [H^+] = 10^{-7}$

$2H^+_{(aq)} + 2e^- \longrightarrow H_{2(g)}$

$$E_{cell} = E^\circ_{cell} - \frac{0.0591}{2}\log\frac{p_{H_2}}{[H^+]^2}$$

$$0 = 0 - \frac{0.0591}{2}\log\frac{p_{H_2}}{(10^{-7})^2}$$

$$\log\frac{p_{H_2}}{(10^{-7})^2} = 0 \Rightarrow \frac{p_{H_2}}{(10^{-7})^2} = 1 \quad [\because \log 1 = 0]$$

$$p_{H_2} = 10^{-14} \text{ atm}$$

21. (a): The cell is represented as

$Tl_{(s)} \mid Tl^+(1.0\text{ M}) \parallel Sn^{4+}(1.0\text{ M}), Sn^{2+}(1.0\text{ M}) \mid Pt$

The cell reaction is $(Tl_{(s)} \longrightarrow Tl^+ + e^-) \times 2$

$Sn^{4+} + 2e^- \longrightarrow Sn^{2+}$

Overall reaction : $2Tl_{(s)} + Sn^{4+} \longrightarrow 2Tl^+ + Sn^{2+}$

$$E = (E^\circ_{Right} - E^\circ_{Left}) - \frac{0.0592}{2}\log\frac{[Tl^+]^2[Sn^{2+}]}{[Sn^{4+}]}$$

$= 0.47$ V $- 0.0296 \log (10)^2$

[$\because$ Tl concentration increases tenfold]

$= 0.47 - 0.0592 = 0.411$ V

22. (d): According to Debye—Hückel's theory, for a strong electrolyte (like NaCl),

$$\lambda_C = \lambda_\infty - (B)\sqrt{C}$$

23. (a): In first case,

Given that, $t = 500$ s; $a = 100$

$$a - x = 80\% \text{ of } 100 = 100 \times \frac{80}{100} = 80$$

For second order reaction, $k = \frac{1}{t \times a} \cdot \frac{x}{a-x}$

$$= \frac{1}{500 \times 100} \times \frac{20}{80} = 5 \times 10^{-6}$$

In second case, $a = 100$

$$a - x = 40\% \text{ of } 100 = 100 \times \frac{40}{100} = 40$$

$$\therefore \quad t = \frac{1}{k \times a} \cdot \frac{x}{a-x} = \frac{1}{5 \times 10^{-6} \times 100} \times \frac{60}{40} = 3000 \text{ s}$$

24. (c): The oxidation reaction is

$$\underset{0.1 \text{ mol}}{\overset{+6}{MnO_4^{2-}}} \longrightarrow \underset{0.1 \text{ mol}}{\overset{+7}{MnO_4^-}} + e^-$$

$Q = 0.1 \times F = 0.1 \times 96500$ C $= 9650$ C

25. (b): Case I : $C = 0.2$ M, $R = 50\ \Omega$, $\kappa = 1.4$ S m^{-1}

$$\kappa = \frac{l}{A} \cdot \frac{1}{R} \text{ or } 1.4 = \frac{l}{A} \cdot \frac{1}{50}$$

$$\Rightarrow \quad \frac{l}{A} = 1.4 \times 50 = 70 \text{ m}^{-1}$$

Case II : $\frac{l}{A} = 70$ m^{-1}, $C = 0.5$ M, $R = 280\ \Omega$,

$$R = \rho\frac{l}{A} \text{ or } \frac{1}{\rho} = \frac{1}{R} \times \frac{l}{A}$$

$$\Rightarrow \quad \frac{1}{\rho} = \frac{1}{280} \times 70$$

$$\kappa = \frac{1}{\rho} = 0.25 \text{ S m}^{-1}$$

Now, $\Lambda_m = \kappa \times \frac{1000}{C}$

If molarity is in mol L^{-1}, then

$$\Lambda_m \text{ (S m}^2 \text{ mol}^{-1}) = \frac{\kappa \text{ (S m}^{-1})}{1000 \text{ L m}^{-3} \times \text{Molarity (mol L}^{-1})}$$

$$= \frac{0.25 \text{ S m}^{-1}}{1000 \text{ L m}^{-3} \times 0.5 \text{ mol L}^{-1}} = 5 \times 10^{-4} \text{ S m}^2 \text{ mol}^{-1}$$

26. (d): $k_{uncat} = Ae^{-\frac{E_{uncat}}{RT}}$ ...(i)

$$k_{cat} = Ae^{-\frac{E_{cat}}{RT}} \quad \text{...(ii)}$$

From (i) and (ii)

$$\frac{k_{uncat}}{k_{cat}} = \frac{e^{-\frac{E_{uncat}}{RT}}}{e^{-\frac{E_{cat}}{RT}}} = e^{\frac{E_{cat} - E_{uncat}}{RT}}$$

$$\frac{k_{uncat}}{k_{cat}} = e^{\frac{-8.314 \times 10^3}{8.314 \times 300}}$$

or $\frac{k_{cat}}{k_{uncat}} = e^{3.33} \approx 28$

27. (c): According to Hardy–Schulze rule, the coagulating power of an electrolyte depends on both magnitude and sign of the charge of the effective ion or electrolyte.

28. (c): $t_{1/2} \propto (a)^{(1-n)}$ or $t_{1/2} = z \cdot (a)^{(1-n)}$

$\therefore \quad \log t_{1/2} = \log z + (1 - n)(\log a)$

It is straight line equation and hence,

slope $= 1 - n = 0 \Rightarrow n = 1$

and for 1st order reaction, $t_{1/2} = \frac{0.693}{K}$

29. (a): Langmuir adsorption isotherm is applicable for monolayer adsorption which fails at high pressure because the mass adsorbed reaches a constant value when the adsorbed surface is completely covered by a unimolecular layer of gases.

30. (c): Collision rate $(z) = N_a N_b \sigma_{ab} \sqrt{\frac{8k_B T}{\pi \mu_{ab}}}$

where, $\sqrt{\frac{8k_B T}{\pi \mu_{ab}}}$ = mean speed

N_a and N_b are number of molecules of 'a' and 'b'.

Monthly Test Drive CLASS XI ANSWER KEY

1. (d)	**2.** (c)	**3.** (d)	**4.** (c)	**5.** (c)
6. (a)	**7.** (a)	**8.** (b)	**9.** (d)	**10.** (d)
11. (a)	**12.** (d)	**13.** (b)	**14.** (c)	**15.** (a)
16. (b)	**17.** (c)	**18.** (b)	**19.** (c)	**20.** (b,c,d)
21. (b,c,d)	**22.** (a,b)	**23.** (a,b,d)	**24.** (3)	**25.** (5)
26. (3)	**27.** (c)	**28.** (b)	**29.** (d)	**30.** (b)

ONCEPT
MAP

GENERAL ORGANIC CHEMISTRY

Nomenclature

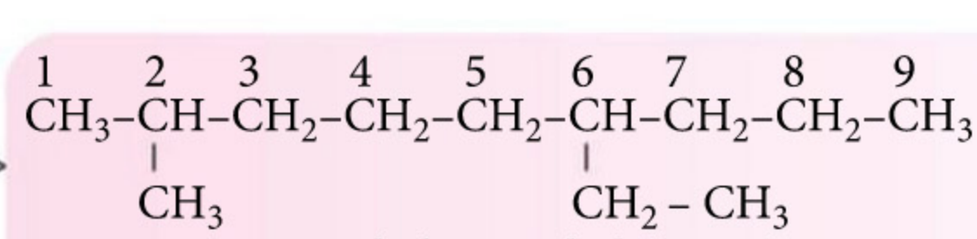
for nomenclature of branched chain alkanes

rst of all, the longest carbon chain in the molecule is identified.

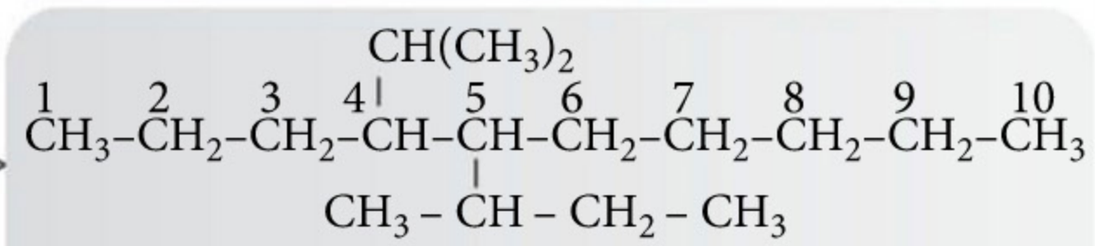
e numbering is done in such a way that the branched carbon atoms t the lowest possible numbers.

the two substituents are found in equivalent positions, the lower mber is given to the one coming first in the alphabetical listing.

hile writing the trivial names of substituents' in alphabetical order, the efixes *iso*-and *neo*-are considered to be the part of the fundamental me of alkyl group. The prefixes *sec*- and *tert*- are not considered to be e part of the fundamental name.



6-Ethyl-2-methylnonane



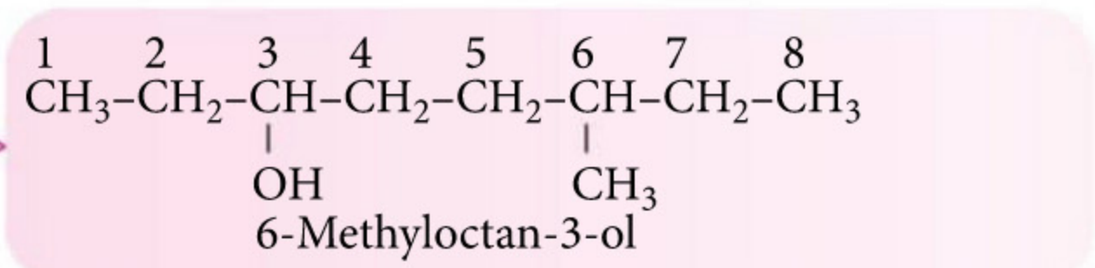
5-*sec*-Butyl-4-isopropyldecane

s for nomenclature of organic compounds with functional groups

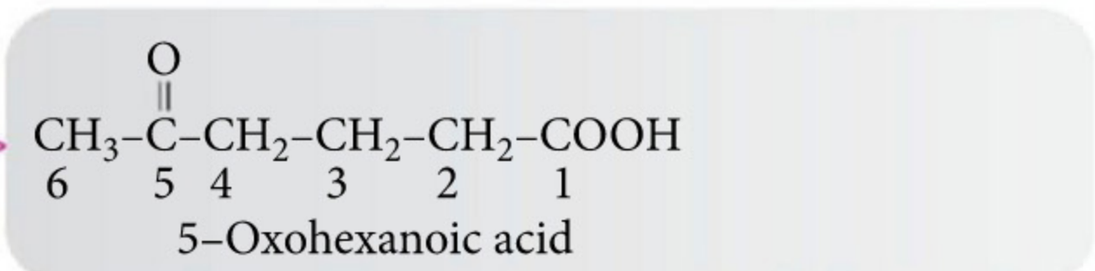
e longest chain of carbon atoms containing the functional group is mbered in such a way that the functional group is attached at the rbon atom possessing lowest possible number in the chain.

the case of polyfunctional compounds, one of the functional groups chosen as the principal functional group and the compound is then med on that basis.

e order of decreasing priority for some functional groups is :
$-COOH$, $-SO_3H$, $-COOR$ (R = alkyl group), $-COCl$, $-CONH_2$, $-CN$, $-CHO$, $>C=O$, $-OH$, $-NH_2$, $>C=C<$, $-C\equiv C-$



6-Methyloctan-3-ol



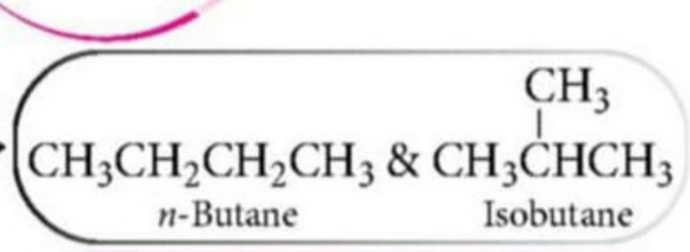
5–Oxohexanoic acid

Isomerism

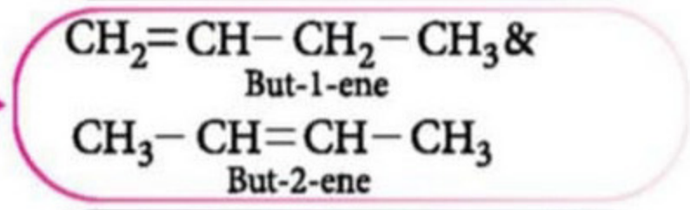
Structural isomerism or constitutional isomerism

ferent compounds have same molecular mula but different structural formula.
mpounds have different IUPAC name.

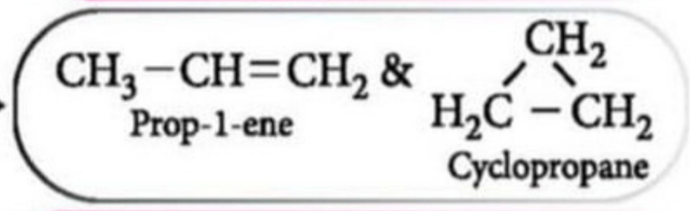
Chain(Nuclear/Skeleton) : Difference in the nature of the carbon chain.



Position : Difference in the position of the substituent atom/group or an unsaturated linkage in the same C-chain.

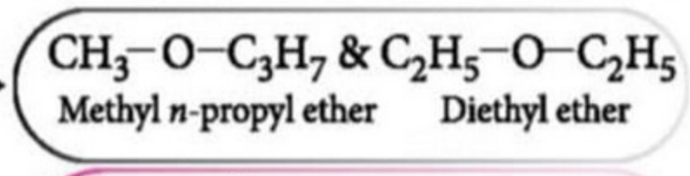


Ring-chain : Difference in mode of linkage of C-atoms.

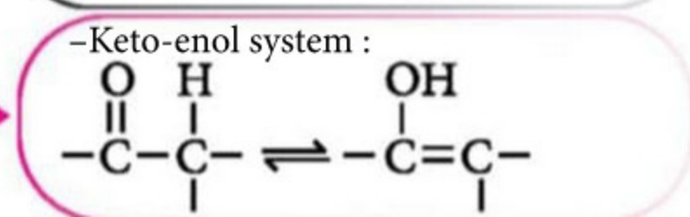


Functional : Difference in the nature of functional group.

Metamerism : Difference in the nature of alkyl groups attached on either side of the same functional group.



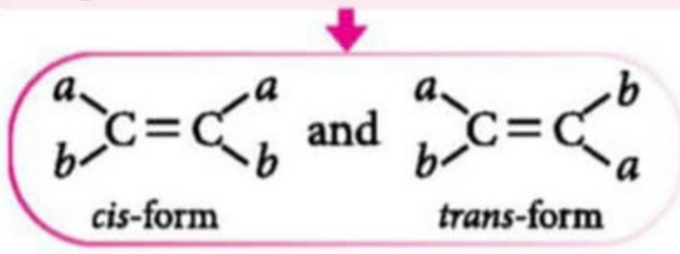
Tautomerism : Isomers exist in dynamic equilibrium.



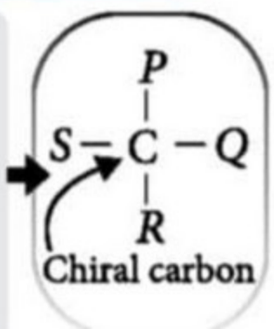
Stereo isomerism

- Different compounds have same molecular formula but different arrangement of atoms in space.
- Compounds have same IUPAC name.

- **Geometrical (*cis-trans*) :** Molecules have identical atomic structures but different geometries.



- **Optical :** Rotate the plane polarised light. Contain an asymmetric (chiral) carbon atom.



Fundamental Concepts in Organic Reaction Mechanism

Fission of a covalent bond

depends upon the electronegativity

Homolytic fission (Similar electronegativity)

$\equiv C : X \longrightarrow \equiv \dot{C} + \dot{X}$

Free radicals

Heterolytic fission (Different electronegativity)

$\equiv C^+ + X^- :$ [Carbocation] (Electronegativity, C < X)

$\equiv C^- : + X^+$ [Carbanion] (Electronegativity, C > X)

Attacking reagent

Electrophiles Positively charged or neutral molecules having electron deficient atom.

- **Charged** $H_3O^+, NO_2^+, NH_4^+, RCO^+$
- **Neutral** $BF_3, BeCl_2, SO_3, \gtrless C = O$

Nucleophiles Negatively charged or neutral molecules having electron rich atom with unshared electron pair.

- **Charged** H^-, OH^-, R^-, CN^-
- **Neutral** $\ddot{N}H_3, H_2\ddot{O}:, R\ddot{O}H, R_3\ddot{N}$

- **Charged** $H_3\ddot{O}^+$
- N

Ambip
Behave lik
electrophi
nucleop

Electronic displacement

Polarisation effect (permanent)

Inductive effect : Inductive effect is an electronic effect due to polarisation of σ bonds within the molecular ion. This is typically due to electronegativity difference.

Electron-donating group (*Y*) exerts a positive inductive effect.

e.g., $(CH_3)_3C-$, $(CH_3)_2CH-$, CH_3CH_2-, CH_3-

Electron-withdrawing group (*X*) exerts a negative inductive effect.

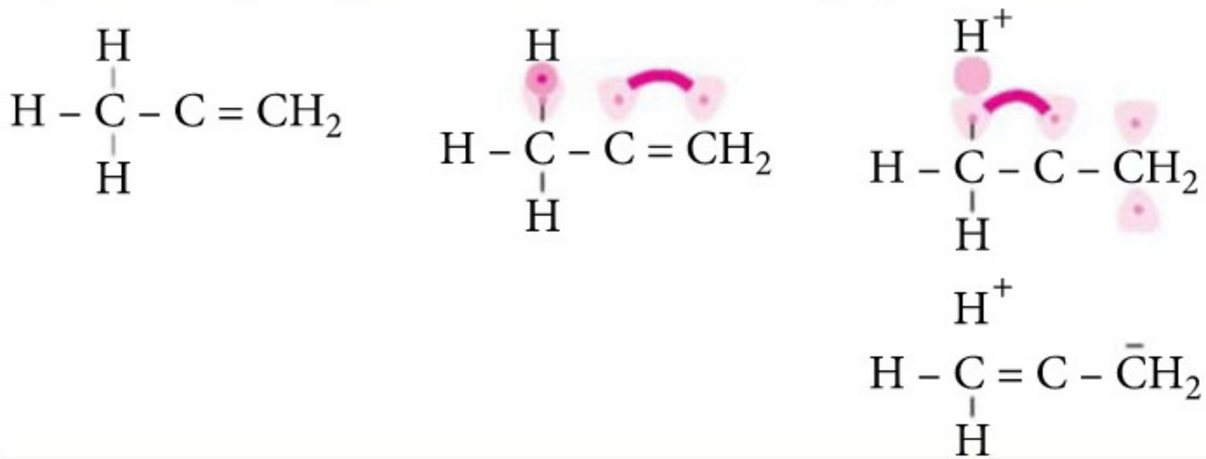
e.g., $\overset{+}{N}F_3$, $\overset{+}{N}H_3$, COOH, F, Cl, Br

Mesomeric effect : Permanent polarisation of a group conjugated with a π-bond or a set of attached π-bond so that full +ve and –ve charge are developed in the molecule then the effect is known as mesomeric effect.

$CH_2 = CH-CH=CH-C(=O) \longleftrightarrow \bar{C}H_2-CH=CH-CH=C(-\bar{O})$

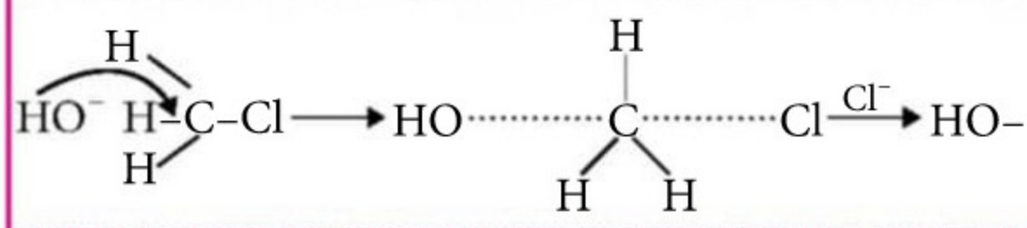
+*M* effect	–*M* effect
–OH, –O*R*, $–NH_2$	–CHO, –CO , –CN, $–NO_2$

Hyperconjugative effect (No-bond resonance) : It involves delocalisation of σ-electrons of C–H bond of an alkyl group directly attached to an atom of unsaturated system or to an atom with an unshared *p*-orbital.



Polarisability effect (temporary)

Inductomeric effect : Inductomeric effect is the tempo
effect which enhances the inductive effect and it acco
only in the presence of an attacking reagent.



In methyl chloride the -*I* effect of Cl is further increa
temporarily by the approach of hydroxyl ion.

Electromeric effect : Electromeric effect refers
a molecular polarizability effect occurring by
intramolecular electron displacement characterized by
substitution of one electron pair for another within
same atomic octet of electrons.

Positive electromeric effect (+*E* effect) ▶ $\gtrless C = C \lessgtr + H^+ \longrightarrow \gtrless \overset{+}{C} -$

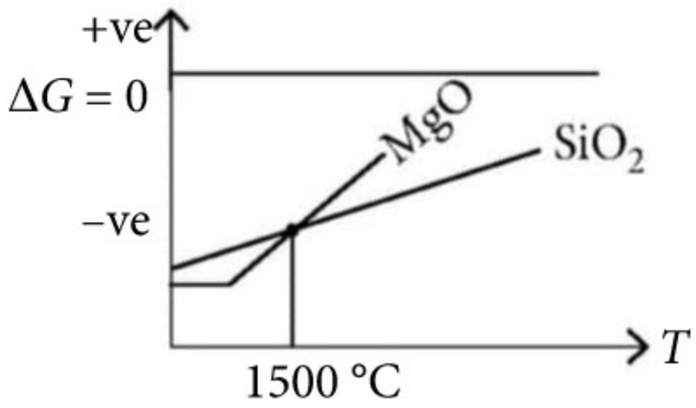
Negative electromeric effect (–*E* effect) ▶ $\gtrless C = C \lessgtr + \bar{C}N \longrightarrow \gtrless C -$ (attacking reagent) CN

GET SET GO for JEE

with exclusive and brain storming MCQs

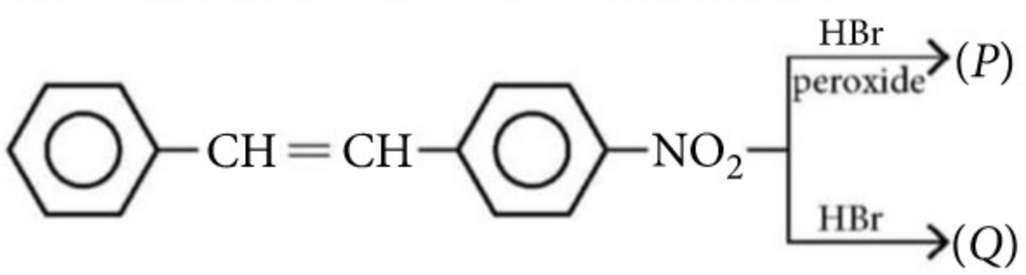
Practicing these MCQs help to strengthen your concepts and give you extra edge in your JEE preparation

1. For this graph which option is correct?



(a) At less than 1500 °C Mg acts as reducing agent for SiO_2.
(b) At more than 1500 °C Si acts as reducing agent for MgO.
(c) Both (a) and (b) (d) None of these

2.

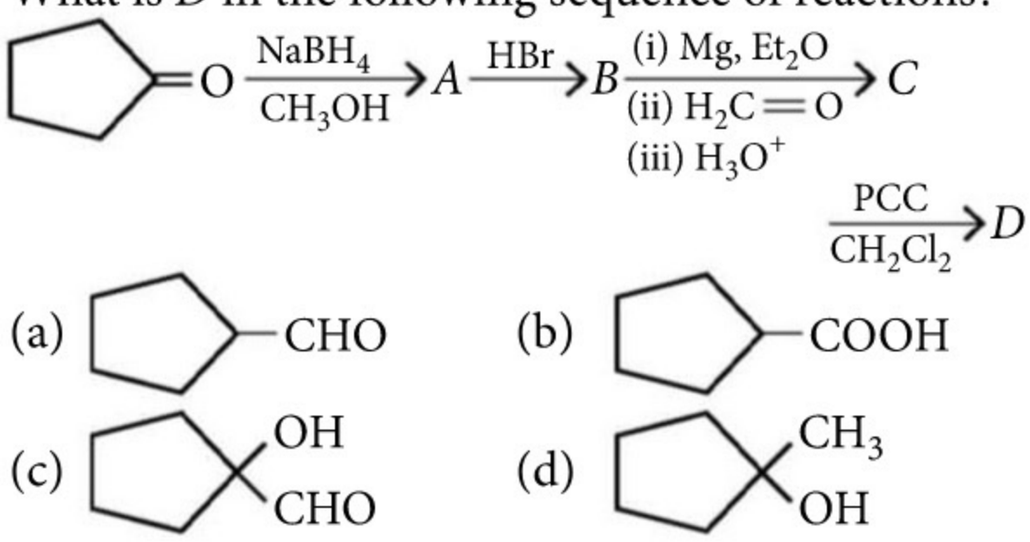


P and *Q* are
(a) position isomers (b) geometrical isomers
(c) optical isomers (d) chain isomers.

3. The unit cell length of NaCl is observed to be 0.5627 nm by X-ray diffraction studies, the measured density of NaCl is 2.164 cm^{-3}. Calculate % of missing Na^+ and Cl^- ions.
(a) 0.882% (b) 0.920%
(c) 0.775% (d) 0.351%

4. If $\Delta_0 < P$, the correct electronic configuration for d^4 system will be
(a) $t_{2g}^4\ e_g^0$ (b) $t_{2g}^3\ e_g^1$ (c) $t_{2g}^0\ e_g^4$ (d) $t_{2g}^2\ e_g^2$

5. What is *D* in the following sequence of reactions?



(a)

(b)

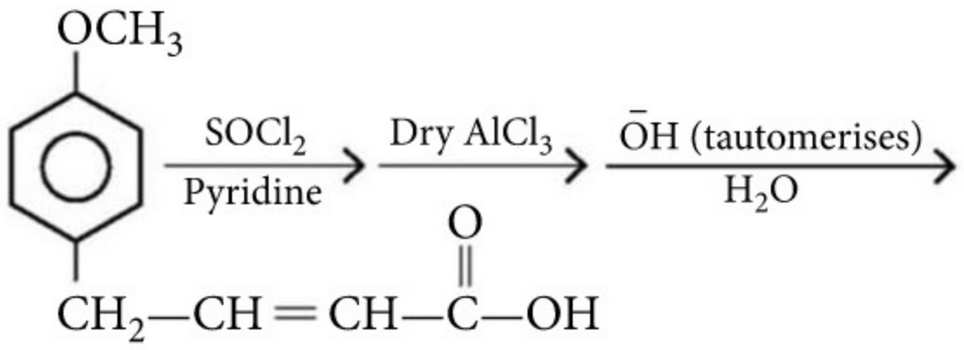
(c)

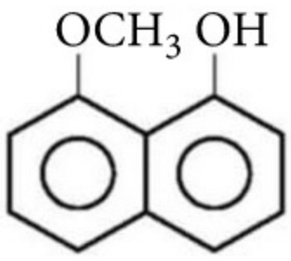
(d)

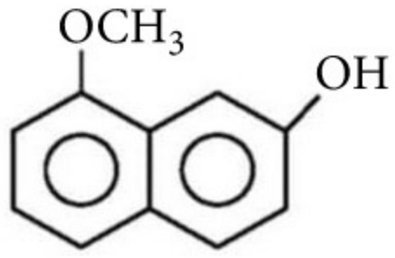
6. The vapour pressure of the solution of two liquids $A(p° = 80$ mm) and $B(p° = 120$ mm) is found to be 100 mm of Hg when $X_A = 0.4$. The result shows that
(a) solution exhibits ideal behaviour
(b) $\Delta H_{solution} < 0$
(c) solution shows positive deviation
(d) solution will show positive deviation for lower concentration and negative deviation for higher concentration.

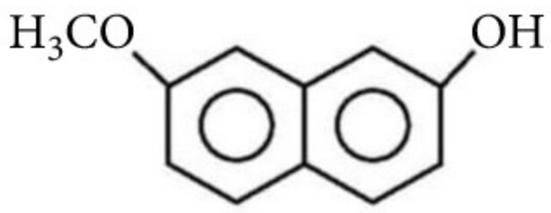
7. Reagent used to distinguish H_2O_2 and O_3 is
(a) PbS (b) potassium iodide
(c) $KMnO_4$ (d) bleaching powder.

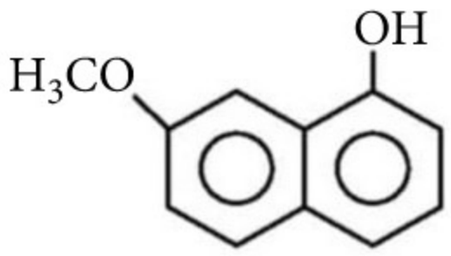
8. The end product of the following reaction sequence is



(a) 

(b) 

(c) 

(d) 

9. Zn gives H_2 gas with H_2SO_4 and HCl but not with HNO_3 because

(a) Zn acts as an oxidising agent when reacts with HNO_3

(b) HNO_3 is weaker acid than H_2SO_4 and HCl

(c) in electrochemical series Zn is above hydrogen

(d) NO_3^- ion is reduced in preference to hydronium ion.

10. An undergraduate student made a Daniell cell using 100 cm^3 of 0.100 M $CuSO_4$ and 0.100 M $ZnSO_4$ solution respectively. The two compartments are connected by suitable salt bridge.

A labmate of the student asked her for some solid $CuCl_2$. While she was lifting the bottle from a shelf, the lid of the bottle slipped and some amount of $CuCl_2$ fell in the $CuSO_4$ compartment at constant volume. She measured the emf of the cell again and found that it had increased by 9 mV. Calculate the mass of $CuCl_2$ that had spilled into the Daniell cell?

(Given : $E^\circ_{Cu^{2+}/Cu} = 0.34$ V, $E^\circ_{Zn^{2+}/Zn} = -0.76$ V)

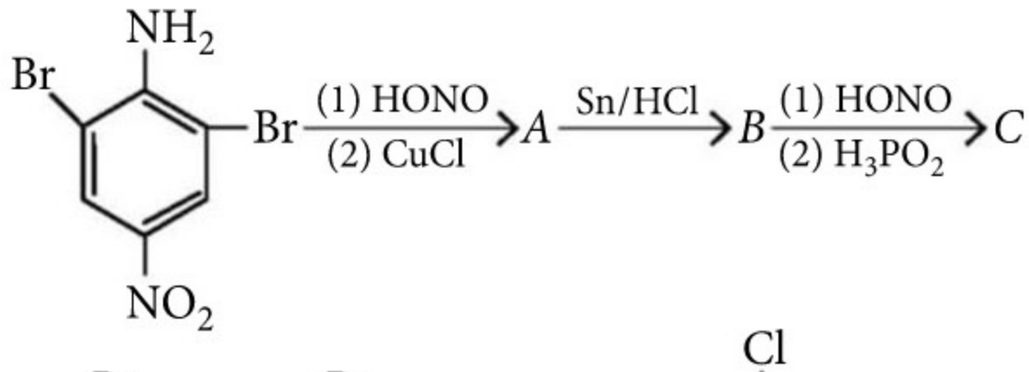
(a) 1.35 g (b) 13.5 g (c) 27 g (d) 2.7 g

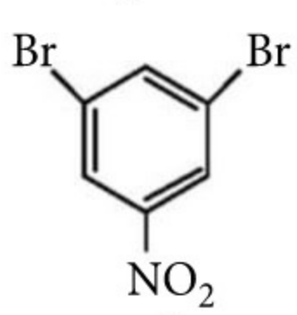
11. Three separate samples of a solution of a single salt gave these results. One formed a white precipitate with excess ammonia solution, one formed a white precipitate with dil. NaCl solution and one formed a black precipitate with H_2S. The salt could be

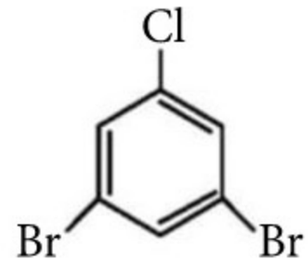
(a) $AgNO_3$ (b) $Pb(NO_3)_2$

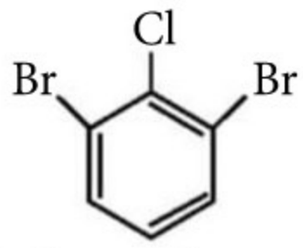
(c) $Hg(NO_3)_2$ (d) $MnSO_4$

12. The product (*C*) obtained in the following sequence of reactions is



(a) 

(b) 

(c) 

(d) none of these.

13. A 1 L reaction vessel which is equipped with a movable piston is filled completely with a 1 M aqueous solution of H_2O_2. The H_2O_2 decomposes to $H_2O_{(l)}$ and $O_{2(g)}$ in a first order process with half life 5 hrs at 300 K. As gas formed, the piston moves up against constant external pressure of 1 atm. What is the net work done by the gas from the start of sixth hour till the end of 10 hrs?

(a) 25 cal (b) 150 cal

(c) 75 cal (d) 100 cal

14. $2CuSO_4 + 2NaCl + SO_2 + 2H_2O \longrightarrow \underset{X}{\text{Compound}} + Na_2SO_4 + 2H_2SO_4$

Compound *X* gradually turns green on exposure in air due to oxidation. Incorrect statement about compound *X* is

(a) compound *X* is CuCl

(b) compound *X* forms black ppt. with H_2S

(c) compound *X* is insoluble in aq. NH_3 solution

(d) compound *X* is soluble in excess of HCl.

Monthly Test Drive CLASS XII ANSWER KEY

1. (a)	**2.** (c)	**3.** (d)	**4.** (c)	**5.** (a)
6. (b)	**7.** (d)	**8.** (c)	**9.** (a)	**10.** (b)
11. (c)	**12.** (b)	**13.** (b)	**14.** (a)	**15.** (c)
16. (a)	**17.** (c)	**18.** (b)	**19.** (d)	**20.** (a,c,d)
21. (b,c)	**22.** (a,b)	**23.** (b,d)	**24.** (4)	**25.** (4)
26. (3)	**27.** (d)	**28.** (b)	**29.** (b)	**30.** (c)

15. How many of the following quantities show increase in their value on increasing temperature?

(i) Extent of physisorption of gases on solids

(ii) Electrical conductivity of metals

(iii) Electrical conductivity of an electrolyte solution

(iv) Ionic product of water

(v) Vapour pressure of a pure liquid

(vi) Vapour pressure of an ideal solution which follows Raoult's law, (keeping composition same)

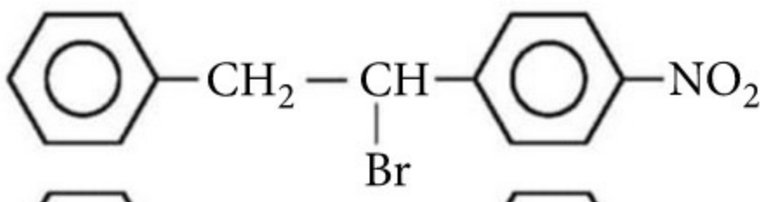
(vii) Solubility of gases in liquids

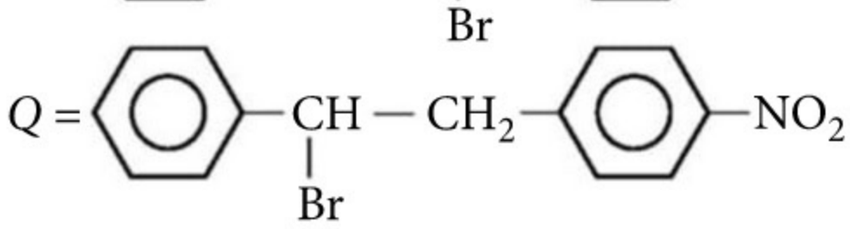
(viii) Reducing power of carbon monoxide for extraction of metals

(a) 5 (b) 4 (c) 6 (d) 3

SOLUTIONS

1. (c)

2. (a) : $P =$ 

$Q =$ 

3. (c) : $\text{Density } (\rho) = \dfrac{z \times M}{N_0 \times a^3}$

$$= \frac{4 \times 58.5}{6.023 \times 10^{23} \times (0.5627 \times 10^{-7})^3} = 2.1806 \text{ g/cm}^3$$

Observed density = 2.164 g/cm^3 which is less than calculated density because some ions are missing.

Acutal units per unit cell can be calculated as

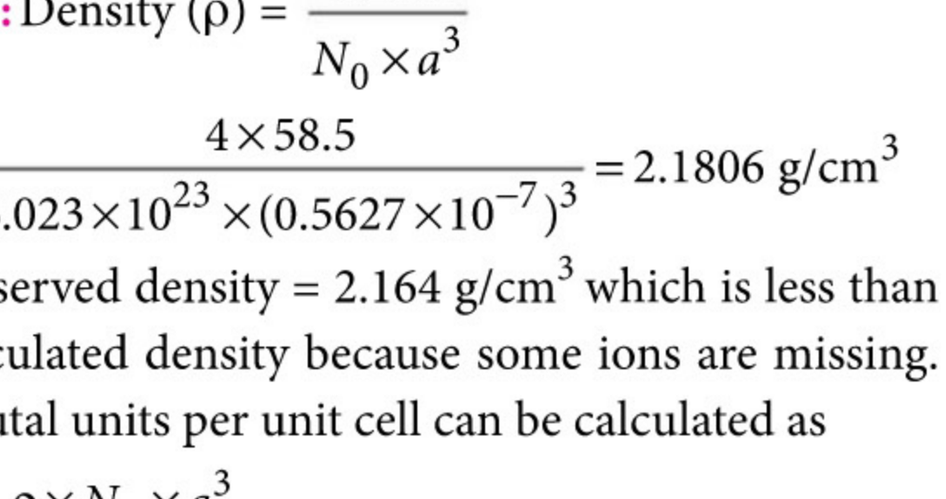
$$z = \frac{\rho \times N_0 \times a^3}{M}$$

$$= \frac{2.164 \times 6.023 \times 10^{23} \times (0.5627 \times 10^{-7})^3}{58.5} = 3.969$$

Missing units = 4 – 3.969 = 0.031

$$\therefore \% \text{ of missing } Na^+ \text{ and } Cl^- = \frac{0.031}{4} \times 100 = 0.775\%$$

4. (b)

5. (a) : 

6. (b) : $P_{\text{Total}} = 0.4 \times 80 + 0.6 \times 120 = 104$

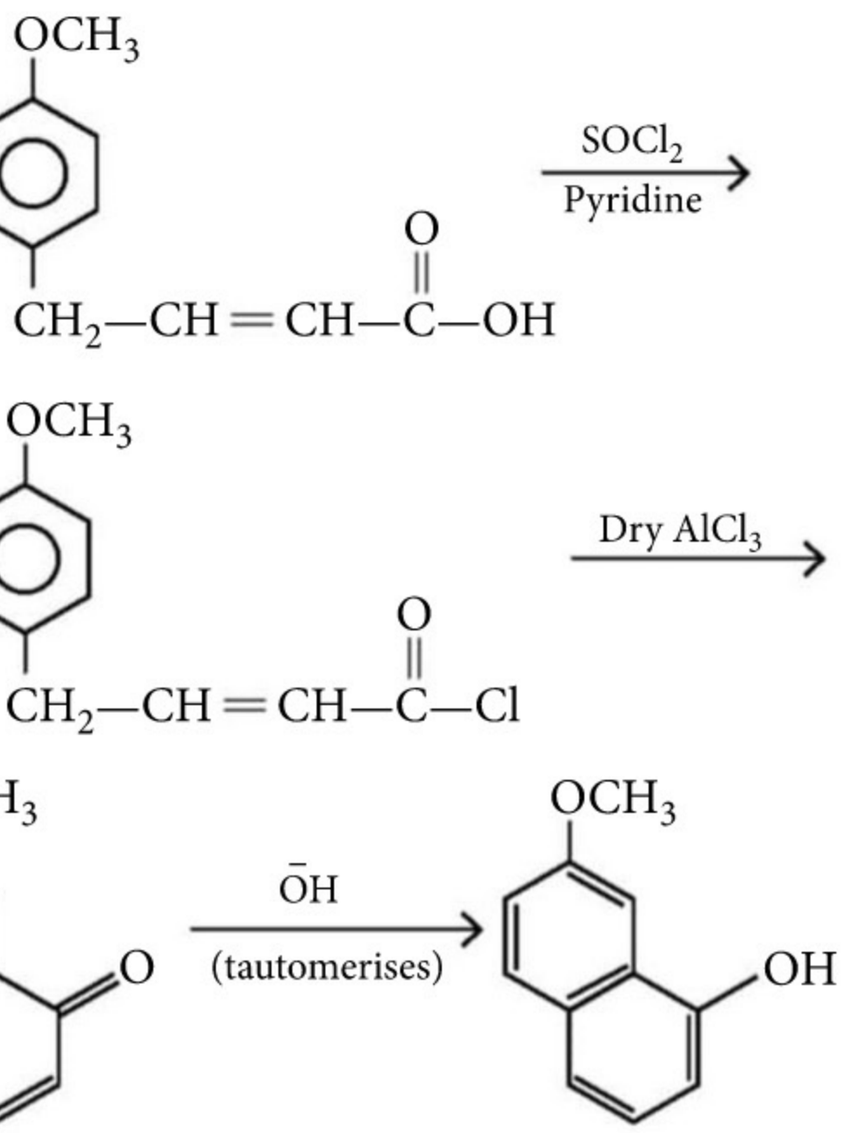
As $p_A + p_B < p^\circ_A X_A + p^\circ_B X_B$

Thus, solution shows negative deviation and for negative deviation $\Delta H_{\text{mix}} < 0$.

7. (c) : The pink colour of $KMnO_4$ is decolorised by H_2O_2 and not by O_3.

$$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5O$$

$$H_2O_2 + O \longrightarrow H_2O + O_2$$

8. (d) : 

9. (d) : NO_3^- ions are reduced by nascent hydrogen.

$$\text{Metal} + HNO_3 \longrightarrow \text{Metal nitrate} + H$$

$$HNO_3 + H \longrightarrow N_2O + H_2O$$

10. (a) : $1.109 = 1.100 - \dfrac{0.059}{2} \log \dfrac{0.1}{[Cu^{2+}]}$

$[Cu^{2+}] = 0.2$ M

$\Delta n = 0.2 \times 0.1 - 0.1 \times 0.1 = 0.01$

$w = 0.01 \times 135 = 1.35$ g

11. (b) **12.** (c)

13. (c) : At the end of 5 hours, $A_{t,1} = A_0/2$

At the end of 10$^{\text{th}}$ hours, $A_{t,2} = A_0/4$

$A_{t,2} - A_{t,1} = A_0/2 - A_0/4 = A_0/4 = 0.25\ A_0$

Amount decayed = 0.25 mol

Moles of O_2 formed = 0.25/2 = 1/8

$w = -P\Delta V = -nRT = -(1/8) \times 300 \times 2$ cal = 75 cal

14. (c) **15.** (b)

MONTHLY TEST DRIVE

This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120

Alcohols, Phenols and Ethers

Time Taken : 60 Min.

NEET

Only One Option Correct Type

1. $CH_3CH_2OH + HCl \xrightarrow{ZnCl_2} CH_3CH_2Cl + H_2O$

In the above reaction, the leaving group is

(a) $[HOZnCl_2]^-$ (b) H_2O

(c) HO^- (d) H_3O^+

2. $C_6H_5OH \xrightarrow[NaOH]{CCl_4} X \xrightarrow[Heat]{Zn\ dust} Y \xrightarrow[(ii)\ Soda\ lime/\Delta]{(i)\ Na} Z$

In the above reaction sequence, Z is

(a) toluene (b) cresol

(c) benzene (d) benzol.

3. In the manufacture of ethanol from sugar the enzymes used are

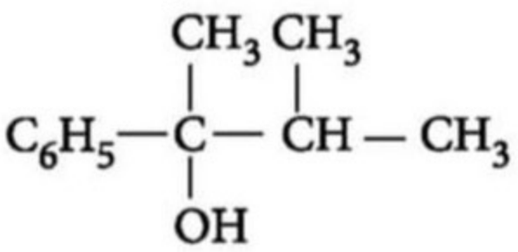
(a) diastase and zymase

(b) maltase and zymase

(c) diastase and invertase

(d) invertase and zymase.

4. Which of the following reagents will convert acetophenone to the given alcohol ?



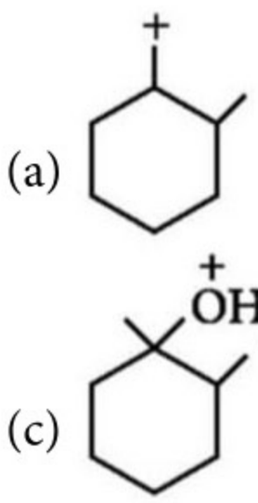
(a) $CH_3CH_2CH_2MgBr$ followed by hydrolysis

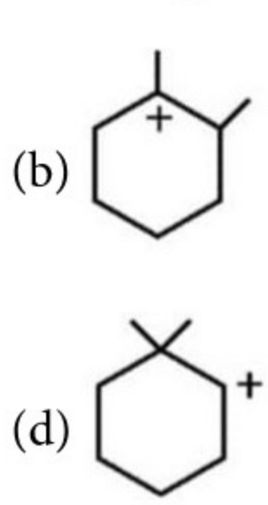
(b) $CH_3CH(Br)CH_3$, $AlCl_3$

(c) $(CH_3)_2CHMgBr$ followed by acid hydrolysis

(d) $CH_3CHOHCH_3$, Zn

5. Which of the following is not expected to be the intermediate of the given reaction?

(a) 

(b) 

(c)

(d)

6. Between *p*-nitrophenol and *p*-cresol, solubility in base is

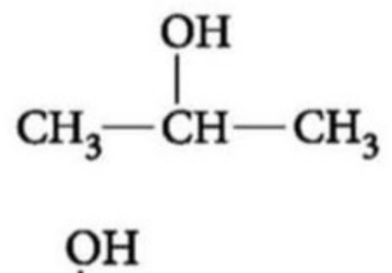
(a) almost nil in both the cases

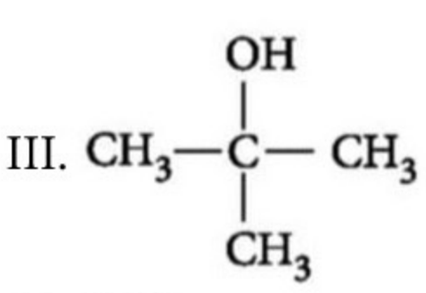
(b) higher for *p*-nitrophenol

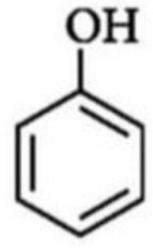
(c) higher for *p*-cresol

(d) equal in both the cases.

7. Which of the following sets of compounds cannot turn clear orange solution of CrO_3/dil. H_2SO_4 to greenish blue solution?

I. CH_3-CH_2-OH II. 

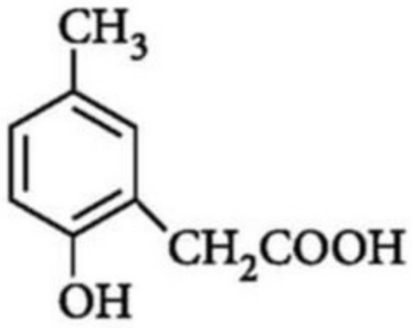
III. 

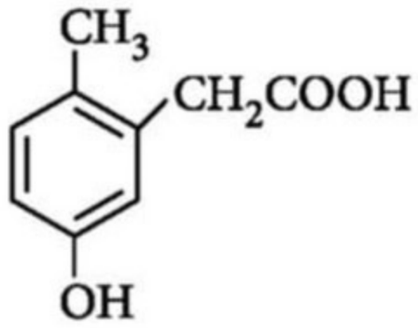
IV. 

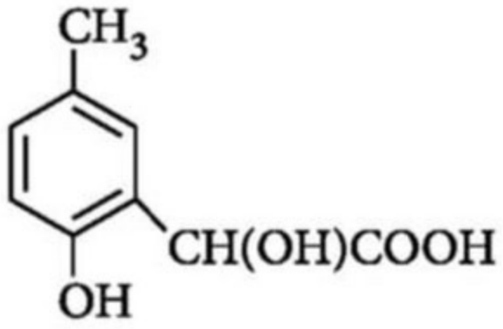
(a) I, IV (b) II, III

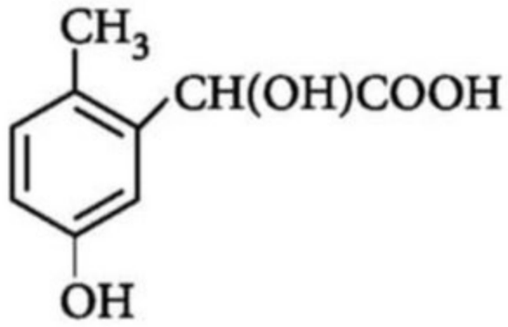
(c) I, II (d) III, IV

8. *p*–Cresol reacts with chloroform in alkaline medium to give a compound *A* which adds hydrogen cyanide to form compound *B*. The latter, on acidic hydrolysis gives chiral carboxylic acid. The structure of the carboxylic acid is

(a) 

(b) 

(c) 

(d) 

9. In the followng reaction,

$$C_2H_5OC_2H_5 \xrightarrow{\text{Red P + HI}} 2X + H_2O$$

X is

(a) ethane (b) ethylene

(c) butane (d) propane.

10. In Williamson's synthesis, ethoxyethane is prepared by

(a) passing ethanol over heated alumina

(b) heating sodium ethoxide with ethyl bromide

(c) treating ethyl alcohol with excess of H_2SO_4 at 430–440 K

(d) heating ethanol with dry Ag_2O.

11. Aluminium *iso*-propoxide is used as a specific reagent for which of the following conversions?

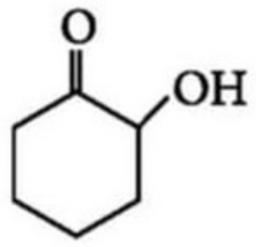
(a) $R-NO_2 \longrightarrow R-NOH$

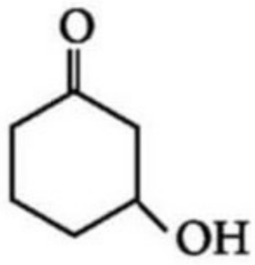
(b) $RCOOR \longrightarrow RCH_2OH$

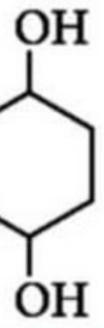
(c) $RCH=CHCHO \longrightarrow RCH=CH-CH_2OH$

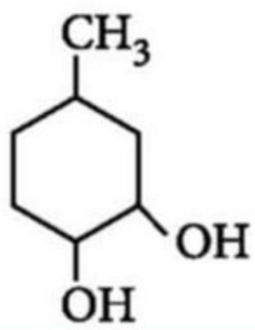
(d) $RCH=CH-CH_2Cl \longrightarrow RCH=CHCH_3$

12. In which of the following maximum dehydration takes place?

(a) 

(b) 

(c) 

(d) 

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of assertion.

(c) If assertion is true but reason is false.

(d) If both assertion and reason are false.

13. **Assertion :** Anisole undergoes electrophilic substitution at *o*- and *p*-positions.
Reason : Anisole is less reactive than phenol towards electrophilic substitution reactions.

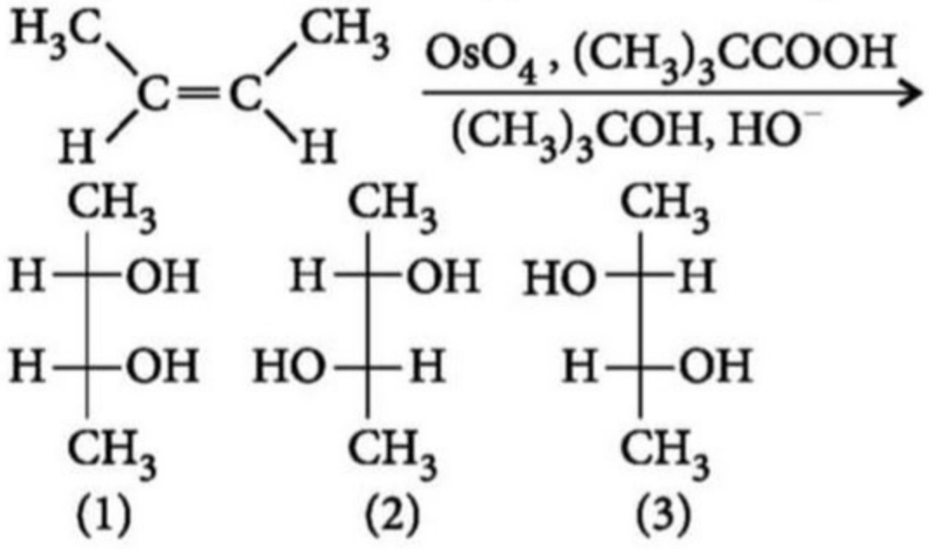
14. **Assertion :** Phenols and alcohols can be distinguished by NaOH.
Reason : Alcohols are very weak acids as compared to phenols.

15. **Assertion :** Solubility of *n*-alcohols in water decreases with increase in molecular mass.
Reason : The proportion of the hydrocarbon part in alcohols increases with increase in molecular mass which permits enhanced hydrogen bonding with water.

JEE MAIN / JEE ADVANCED

Only One Option Correct Type

16. What is/are the product(s) of the following reaction?

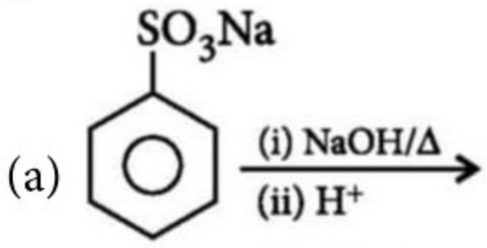


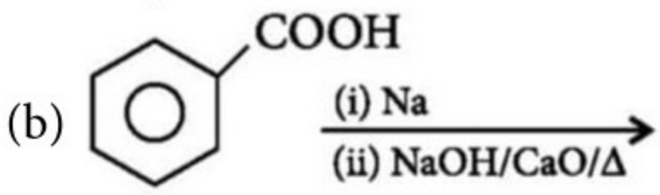
(1) (2) (3)

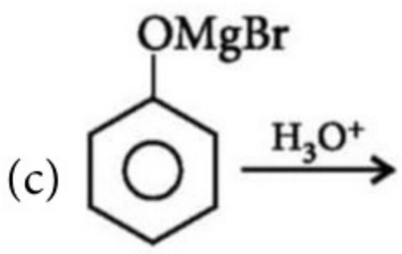
(a) Only 1
(b) 1 : 1 mixture of 2 and 3
(c) Only 2
(d) 1 : 1 : 1 mixture of 1, 2 and 3

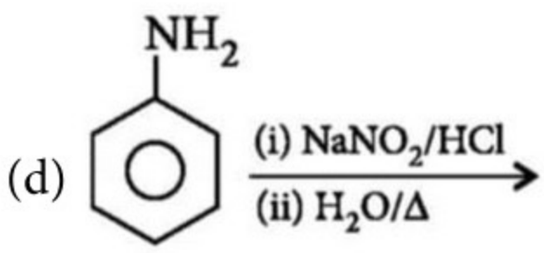
17. An organic compound *A* reacts with methyl magnesium iodide to form an addition product which on hydrolysis forms the compound *B*. Compound *B* gives blue colour salt in Victor Meyer's test. The compounds *A* and *B* are respectively
(a) acetaldehyde, tertiary butyl alcohol
(b) acetaldehyde, ethyl alcohol
(c) acetaldehyde, isopropyl alcohol
(d) acetone, isopropyl alcohol.

18. Which of the following reactions does not yield phenol?

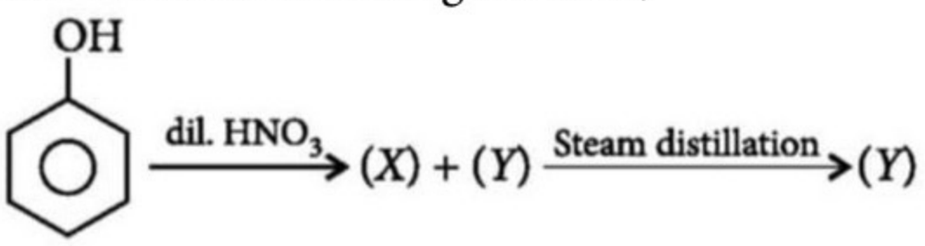
(a) 

(b) 

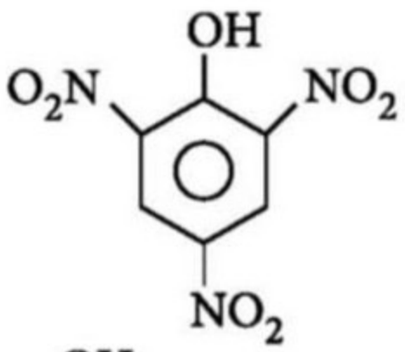
(c) 

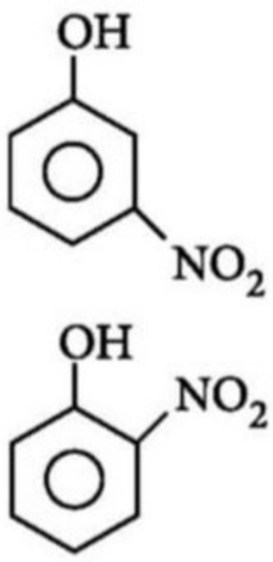
(d) 

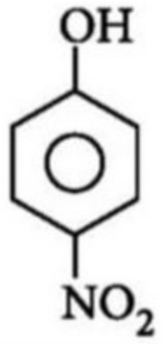
19. Consider the following reaction,



Low boiling fraction '*Y*' is

(a) 

(b) 

(c) 

(d)

More than One Options Correct Type

20. Which of the following statements about ethers are correct?
(a) Ethers are relatively inert compounds.
(b) Ethers are weakly acidic.
(c) Ethers form oxonium salts.
(d) Ethers form stable complexes with Lewis acids.

21. Propan-1-ol and propan-2-ol can be best distinguished by
(a) oxidation with alkaline $KMnO_4$ followed by reaction with H_2O
(b) oxidation with PCC followed by reaction with Tollens' reagent
(c) heating with copper followed by reaction with iodoform
(d) reaction with conc. H_2SO_4 followed by reaction with Fehling's solution.

22. Which of the following reactions give 2-butanol as a product?

(a) $CH_3-CH=O \xrightarrow[(ii)\ H_2O/H^+]{(i)\ CH_3-CH_2-MgBr}$

(b) $CH_3-CH_2-CH=O \xrightarrow[(ii)\ H_2O/H^+]{(i)\ CH_3-MgBr}$

(c) $\begin{matrix}CH_3\\CH_3\end{matrix}\!\!>\!C=O \xrightarrow[(ii)\ H_2O/H^+]{(i)\ CH_3-CH_2-MgBr}$

(d) $CH_2=O \xrightarrow[(ii)\ H_2O/H^+]{(i)\ CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-MgBr}$

23. Diethyl ether can be distinguished from *n*-butanol by
(a) aqueous $FeCl_3$ solution
(b) reaction with Na metal
(c) Tollens' reagent
(d) reaction with chromic anhydride (CrO_3) in dil. H_2SO_4.

Numerical Value Type

24. Among the following, the number of alcohols showing iodoform test is

CH_3OH, CH_3CH_2OH, $(CH_3)_2CHOH$, $(CH_3)_3C-OH$, $CH_3CH_2CH_2CH_2OH$, $CH_3CHOHCH_2CH_3$, $CH_3CH_2CH_2OH$, $(C_2H_5)_2CHOH$, $CH_3CHOHCH(CH_3)_2$

25. How many of the following substances are less acidic than ethyl alcohol?

Water, acetylene, carbonic acid, methanol, *iso*-propyl alcohol, phenol, *tert*-butyl alcohol, *n*-propyl alcohol

26. How many ethers will be formed when a mixture of ethyl alcohol and methyl alcohol is treated with conc. H_2SO_4?

Comprehension Type

The cleavage of ethers to give the original alkyl halide and the alcohol is carried out by heating the ether with a halogen acid. Usually, HI at 373 K is used, but some ethers can be cleaved even by HBr or HCl. Depending upon the nature of the alky/aryl groups around the oxygen atom and the polarity of the solvent in which HI is dissolved, the reaction may follow either S_N2 or S_N1 mechanism.

27. Which of the following ethers is cleaved even by hydrogen chloride at room temperature?

(a) $C_6H_5-O-CH_2CH_3$

(b) $CH_3CH_2-O-CH_2CH_3$

(c) $(CH_3)_3C-O-CH_2CH_3$

(d) $(CH_3)_3C-O-C(CH_3)_3$

28. The major products formed when the following ether is heated with conc. HI

$CH_3CH_2CH_2-O-C(CH_3)_2CH_2CH_3$

are

(a) $CH_3CH_2CH_2I + HO-C(CH_3)_2CH_2CH_3$

(b) $CH_3CH_2CH_2OH + I-C(CH_3)_2CH_2CH_3$

(c) $CH_3CH_2CH_2I + I-C(CH_3)_2CH_2CH_3$

(d) $CH_3CH_2CH_2OH + (CH_3)_2C=CHCH_3$

Matrix Match Type

29. Match column I with column II and choose the correct option using the codes given below :

Column I	Column II
(A) Obtained by reaction between ethyl acetate and excess of CH_3MgBr followed by acidic hydrolysis	(p) CH_3CH_2OH
(B) Gets easily oxidised by $K_2Cr_2O_7/H_2SO_4$	(q) $CH_3CH_2CHOHCH_3$
(C) Produces blue colouration in Victor-Meyer's test	(r) C_6H_5OH
(D) Produces violet colouration with neutral $FeCl_3$ solution	(s) $(CH_3)_3COH$

	A	B	C	D
(a)	p	s	r	q
(b)	s	p	q	r
(c)	q	r	p	s
(d)	r	q	s	p

30. Match column I with column II and choose the correct option using the codes given below :

Column I	Column II
(A) Phenol + Neutral $FeCl_3$	(p) No reaction
(B) Phenol + $Br_{2(aq.)}$	(q) Violet colour
(C) Phenol + $NaHCO_3$	(r) White ppt.
(D) Picric acid + $NaHCO_3$	(s) CO_2 gas is evolved

	A	B	C	D
(a)	p	r	q	s
(b)	s	p	q	r
(c)	q	r	p	s
(d)	p	q	s	r

◈◈

Keys are published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted .....

No. of questions correct .....

Marks scored in percentage .....

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

CBSE warm-up!

CLASS-XII

Practice questions for CBSE Exams as per the reduced syllabus, latest pattern and marking scheme issued by CBSE for the academic session 2020-21.

Series 2

CHAPTERWISE PRACTICE PAPER : Electrochemistry | Chemical Kinetics | Surface Chemistry

Time Allowed : 3 hours
Maximum Marks : 70

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them :

(i) Question paper comprises two parts A and B.

(ii) Part A : Q. no. 1 to 26 are objective type questions.
Q. no. 1 to 19 are objective type questions carrying one mark each.
Q. no. 20 to 24 are objective type questions carrying two marks each.
Q. no. 25 to 26 are case based objective type questions carrying three marks each.

(iii) Part B : Q. no. 27 to 37 are subjective/descriptive type questions.
Q. no. 27 to 30 are short answer type-I questions carrying two marks each.
Q. no. 31 to 34 are short answer type-II questions carrying three marks each.
Q. no. 35 to 37 are long answer type questions carrying five marks each.

(iv) There is no overall choice in the question paper. However, internal choices have been provided in both part A and Part B.

(v) Use of calculators and log tables is not permitted.

PART - A

1. The rate of a first order reaction is 1.8×10^{-3} mol L^{-1} min^{-1} when the initial concentration is 0.3 mol L^{-1}. The rate constant is

(a) $1 \times 10^{-2}\ s^{-1}$ (b) $1 \times 10^{-4}\ s^{-1}$
(c) $6 \times 10^{-2}\ s^{-1}$ (d) $4 \times 10^{-4}\ s^{-1}$

2. $Li^+/Li = -3.05$ V; $Ba^{2+}/Ba = -2.73$ V; $Mg^{2+}/Mg = -2.37$ V

The correct order as per reducing power is

(a) Li > Ba > Mg (b) $Li^+ > Ba^{2+} > Mg^{2+}$
(c) Mg > Ba > Li (d) $Mg^{2+} > Ba^{2+} > Li^+$

3. Which of the following is not correct?

(a) Rate of zero order reaction depends upon initial concentration of reactant.
(b) Rate of zero order reaction does not depend upon initial concentration of reactant.
(c) $t_{1/2}$ of first order reaction is independent of initial concentration of reactant.
(d) $t_{1/2}$ of zero order reaction is dependent of initial concentration of reactant.

4. When the concentration of an adsorbate is higher on the surface of adsorbent than in the adjoining bulk, the phenomenon is called

(a) chemisorption (b) physisorption
(c) positive adsorption
(d) negative adsorption.

5. $\Lambda°\ ClCH_2COONa = 224\ ohm^{-1}\ cm^2\ g\ eq^{-1}$, $\Lambda°NaCl = 38.2\ ohm^{-1}\ cm^2\ g\ eq^{-1}$, $\Lambda°HCl = 203\ ohm^{-1}\ cm^2\ g\ eq^{-1}$, what is the value of $\Lambda\ °ClCH_2COOH$?

(a) 288.5 ohm^{-1} cm^2 g eq^{-1}
(b) 289.5 ohm^{-1} cm^2 g eq^{-1}
(c) 388.8 ohm^{-1} cm^2 g eq^{-1}
(d) 59.5 ohm^{-1} cm^2 g eq^{-1}

6. What is the value of $1/n$, in Freundlich adsorption isotherm?
(a) Between 2 and 4 in all cases
(b) Between 0 and 1 in all cases
(c) 1 in case of chemisorption
(d) 1 in case of physical adsorption

OR

If a homogeneous colloid placed in dark is observed in the direction of light, it appears clear and if it is observed from a direction at right angles to the direction of light beam, it appears perfectly dark. This is known as
(a) Brownian effect (b) Hardy Schulze effect
(c) Einstein effect (d) Tyndall effect.

7. Following two half cells form a complete cell which has ΔG° (in kJ) value
$2H^+ + 1/2\ O_2 + 2e^- \rightarrow H_2O$; $E^\circ = +1.23$ V
$Fe^{2+} + 2e^- \rightarrow Fe_{(s)}$; $E^\circ = -0.44$ V
(a) –122 (b) –222 (c) –322 (d) –422

8. Which of the following relation is correct for zero order reaction?
(a) $t_{3/4} = 2t_{1/2}$ (b) $t_{3/4} = 1.5\ t_{1/2}$
(c) $t_{3/4} = \frac{1}{2}t_{1/2}$ (d) $t_{3/4} = \frac{1}{3}t_{1/2}$

9. Which one of the following is wrong about physical adsorption?
(a) It involves only van der Waals' forces of attraction.
(b) It has low heat of adsorption.
(c) It is reversible in nature.
(d) It forms a unimolecular layer on the surface of the adsorbent.

OR

According to adsorption theory of catalysis, the speed of the reaction increases because
(a) the concentration of the reactant molecules at the active centres of the catalyst becomes high due to adsorption
(b) in the process of adsorption, the activation energy of the molecules becomes large
(c) adsorption produces heat which increases the speed of the reaction
(d) adsorption lowers the activation energy of the reaction.

10. Given : $Zn^{2+}/Zn = -0.76$ V, $Mg^{2+}/Mg = -2.37$ V, then the correct statement about the reaction
$Zn_{(s)} + MgCl_{2(aq)} \rightarrow$
(a) solid zinc dissolves
(b) zinc chloride precipitates
(c) magnesium chloride precipitates
(d) no reaction takes place.

OR

The half cell potential of a hydrogen electrode at pH = 10 will be
(a) – 0.50V (b) – 0.59V
(c) 0.059V (d) none of these

11. All colloidal dispersions have
(a) very high osmotic pressure
(b) low osmotic pressure
(c) no osmotic pressure
(d) high osmotic pressure.

12. Which is not the example of coagulation?
(a) Curdling of milk
(b) Purification of water by addition of alum
(c) Rubber plating
(d) Formation of deltas at the river beds

13. Associated colloids
(a) raise both the surface tension and viscosity of water
(b) lower both the surface tension and viscosity of water
(c) lower the surface tension and raise the viscosity of water
(d) have greater concentration at the surface layer than the bulk of the solution.

OR

Amongst the following, the surfactant that will form micelles in aqueous solution at the lowest molar concentration at ambient condition is
(a) $CH_3(CH_2)_{15}N^+(CH_3)_3Br^-$
(b) $CH_3(CH_2)_{11}OSO_3^-Na^+$
(c) $CH_3(CH_2)_6COO^-Na^+$
(d) $CH_3(CH_2)_{11}N^+(CH_3)_3Br^-$

14. The rate of a chemical reaction does not increase
(a) if the temperature is increased
(b) if the surface area of the reactant is increased
(c) if the concentration of the reactants is increased
(d) with time.

Question 15 to 19. (Assertion/Reason)

Directions : In the following questions (15-19), a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) If both Assertion (A) and Reason (R) are correct and Reason (R) is the correct explanation of Assertion (A).
(b) If both Assertion (A) and Reason (R) are correct but Reason (R) is not the correct explanation of Assertion (A).
(c) If Assertion (A) is correct but Reason (R) is incorrect.
(d) If Assertion (A) is incorrect and Reason (R) is correct.

15. **Assertion :** If standard reduction potential for the reaction, $Ag^+ + e^- \rightarrow Ag$ is 0.80 volt, then for the reaction, $2Ag^+ + 2e^- \rightarrow 2Ag$, it will be 1.60 volt.
Reason : Standard reduction potential of an electrode has a fixed value and does not affected by concentration.

16. **Assertion :** When KI solution is added to $AgNO_3$ solution, negatively charged sol results.
Reason : It is due to preferential adsorption of silver ions from the dispersion medium.

OR

Assertion : In physical adsorption, enthalpy of adsorption is very low.
Reason : In physical adsorption, attraction between gas molecules and solid surface is due to weak van der Waals' forces.

17. **Assertion :** For the reaction,
$CHCl_3 + Cl_2 \rightarrow CCl_4 + HCl$
$\text{Rate} = k[CHCl_3][Cl_2]^{1/2}$
Reason : Rate of reaction is always equal to the sum of the stoichiometric coefficients of the reacting species in a balanced chemical equation.

18. **Assertion :** For the Daniell cell,
$Zn\,|\,Zn^{2+}\,||\,Cu^{2+}\,|\,Cu$ with $E_{cell} = 1.1$ V, the application of opposite potential greater than 1.1 V results into the flow of electrons from cathode to anode.
Reason : Zinc is deposited at anode and Cu is dissolved at cathode.

OR

Assertion : Copper(II) iodide is not known.
Reason : Cu^{2+} oxidises I^- to I_2.

19. **Assertion :** The reaction

$$\underset{\text{Cane sugar}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

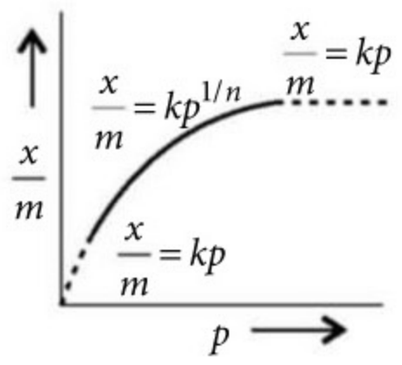
is a first order reaction.
Reason : Change in concentration of H_2O is negligible.

20. If $E^\circ_{Fe^{2+}/Fe} = x_1$ V, $E^\circ_{Fe^{3+}/Fe^{2+}} = x_2$ V, what is the $E^\circ_{Fe^{3+}/Fe}$?
(a) $\frac{2x_1 + x_2}{4}$ (b) $\frac{2x_1 + x_2}{3}$
(c) $\frac{2x_1 + x_2}{2}$ (d) $2x_1 + x_2$

OR

For a cell reaction involving two electron change, the standard EMF of the cell is 0.295 V at 25 °C. The equilibrium constant of the reaction at 25 °C will be
(a) 29.5×10^{-2} (b) 10
(c) 1×10^{10} (d) 2.95×10^{-10}

21. Which one is not correct about Freundlich isotherm?
(a) $n = \frac{1}{\tan\theta}$ at average pressure
(b) $\theta = 45°$ at low pressure
(c) $\theta = 45°$ at high pressure
(d) None of these



22. If the rate of a reaction at 50 °C is 2.6×10^{-3} mol L^{-1} s^{-1}, then what will be rate of reaction at 80 °C? (Given that the temperature coefficient is 3.)
(a) 7.02×10^{-2} (b) 7.025×10^{-3}
(c) 7.8×10^{-3} (d) None of these

OR

For the reaction, $2NO_2 \rightarrow N_2O_2 + O_2$, rate expression is as follows : $\frac{d[NO_2]}{dt} = k[NO_2]^n$, where, $k = 3 \times 10^{-3}$ mol^{-1} L sec^{-1}. If the rate of formation of oxygen is 1.5×10^{-4} mol L^{-1} sec^{-1}, then the molar concentration of NO_2 in mol L^{-1} is
(a) 1.5×10^{-4} (b) 0.0151
(c) 0.214 (d) 0.316

23. Following are the properties related to adsorption :
I. Reversible
II. Results into unimolecular layer
III. Low heat of adsorption
IV. Occurs at low temperature and decreases with increasing temperature.
Which of the above properties are for physical adsorption?
(a) I, II, III only (b) I, III, IV only
(c) II, III, IV only (d) I, III only

24. The rate of reaction between A and B increases by a factor of 100, when the concentration of A is increased 10 folds, the order of reaction with respect to A is
(a) 2 (b) 3 (c) 1 (d) 4

Read the following passage and answer the questions 25 and 26.

Order of reaction is an experimentally determined quantity. It may be zero, positive, negative and fractional. The kinetic energy equation of n^{th} order reaction is

$$k \times t = \frac{1}{(n-1)}\left[\frac{1}{(a-x)^{n-1}} - \frac{1}{a^{n-1}}\right]$$

Unit of the rate constant varies with the order but general relation for unit of n^{th} order reaction is

$$\text{unit of } k = \left[\frac{1}{\text{conc.}}\right]^{n-1} \times \text{time}^{-1}$$

25. The rate constant for zero order reaction is

(a) $k = \frac{C_0}{2t}$ (b) $k = \frac{C_0 - C_t}{t}$

(c) $k = \ln\frac{C_0 - C_t}{2t}$ (d) $k = \frac{C_0}{C_t}$

where C_0 and C_t are concentrations of reactants at respective times

26. In a chemical reaction $A \rightarrow B$, it is found that the rate of the reaction doubles when the concentration of A is increased four times. The order of the reaction with respect to A is

(a) 0 (b) 1/2

(c) 1 (d) 2.

PART - B

27. How would you test whether the given electrolyte is strong electrolyte or weak electrolyte by the measurement of conductivity?

28. The gas phase decomposition of acetaldehyde,

$CH_3CHO_{(g)} \longrightarrow CH_{4(g)} + CO_{(g)}$

follows the rate expression :

Rate $= -[CH_3CHO] / dt = k[CH_3CHO]^{3/2}$

In terms of the partial pressure of acetaldehyde, it can be expressed as

$$-\frac{dp_{CH_3CHO}}{dt} = k(p_{CH_3CHO})^{3/2}$$

If the pressures is measured in the units of atmosphere and time in minutes then,

(a) what is the unit of rate of reaction?

(b) what is the unit of the rate constant, k?

OR

The rate constant for a first order reaction is 60 s^{-1}. How much time will it take to reduce the initial concentration of the reactant to its $1/16^{th}$ value?

29. For a first order reaction, show that time required for 99% completion is twice the time required for the completion of 90% of reaction.

30. **(i)** Define standard electrode potential.

(ii) What is the use of platinum foil in SHE?

31. In an adsorption experiment, a graph between $\log\left(\frac{x}{m}\right)$ and log P was found to be linear with a slope of 45°. The intercept on the $\log\left(\frac{x}{m}\right)$ axis was found to be 0.3010. Calculate the amount of the gas adsorbed per gram of the adsorbent under a pressure of 0.5 atm.

OR

What is the difference between multimolecular and macromolecular colloids? Give one example of each type. How are associated colloids different from these two types of colloids ?

32. Give reasons for the following observations :

(a) Peptizing agent is added to convert precipitate into colloidal solution.

(b) Cottrell's smoke precipitator is fitted at the mouth of the chimney used in factories.

(c) Colloidal gold is used for intramuscular injection.

33. A voltaic cell is set up at 25°C with the following half cells :

Al/Al^{3+} (0.001 M) and Ni/Ni^{2+} (0.50 M)

Write an equation for the reaction that occurs when the cell generates an electric current and determine the cell potential.

$E°_{Ni^{2+}/Ni} = -0.25$ V and $E°_{Al^{3+}/Al} = -1.66$ V.

$(\log 8 \times 10^{-6} = -5.09)$

34. **(i)** Plot a curve between $t_{1/2}$ and $[A]_0$ for the firstorder reaction.

(ii) With the help of an example explain what is meant by pseudo first order reaction.

35. Starting from 10 g of a radioactive element, 0.25 g was left after 5 years. Calculate

(i) rate constant for the decay of the radioactive element.

(ii) the amount left after one year.

(iii) the time required for half of the element to decay.

OR

The initial rate of reaction :

$A + 5B + 6C \longrightarrow 3D + 3E$

has been determined by measuring the rate of disappearance of A under the following conditions :

Expt. No.	$[A]_0$ (M)	$[B]_0$ (M)	$[C]_0$ (M)	Initial rate (M min^{-1})
1.	0.02	0.02	0.02	2.08×10^{-3}
2.	0.01	0.02	0.02	1.04×10^{-3}
3.	0.02	0.04	0.02	4.16×10^{-3}
4.	0.02	0.02	0.04	8.32×10^{-3}

(i) Determine the order of reaction with respect to each reactant.

(ii) What is the rate constant?

(iii) Calculate the initial rate of the reaction when the concentration of all the reactants is 0.01 M.

36. (a) Write the Nernst equation.

(b) Calculate the emf of the following cells at 298 K :

(i) $Mg_{(s)} \mid Mg^{2+}(0.001\ M) \parallel Cu^{2+}(0.0001\ M) \mid Cu_{(s)}$

(ii) $Fe_{(s)} \mid Fe^{2+}(0.001\ M) \parallel H^+(1\ M) \mid H_{2(g)}(1\ bar) \mid Pt_{(s)}$

[Given : $E°_{Mg2+/Mg} = -2.37$ V, $E°_{Cu2+/Cu} = 0.34$ V, $E°_{Fe2+/Fe} = -0.44$ V]

OR

Answer the following :

(a) Suggest a way to determine $\Lambda°_m$ value of water.

(b) The molar conductivity of 0.025 mol L^{-1} methanoic acid is 46.1 S cm^2 mol^{-1}. Calculate its degree of dissociation and dissociation constant. Given

$\lambda°_{(H^+)} = 349.6$ S cm^2 mol^{-1} and

$\lambda°_{(HCOO^-)} = 54.6$ S cm^2 mol^{-1}

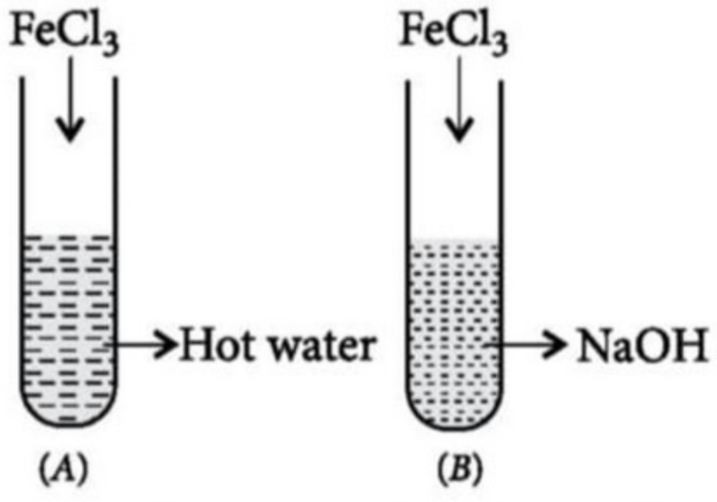
37. (i) What type of colloidal sols are formed in the following :

(a) Sulphur vapours are passed through cold water.

(b) White of an egg is mixed with water.

(c) Soap solution?

(ii) A colloidal solution of ferric oxide is prepared by two different methods as shown below :



(a) What is the charge on colloidal particles in the two test tubes (*A*) and (*B*)?

(b) Give reasons for the origin of charge.

OR

(i) Explain the following observations :

(a) Sun looks red at the time of sunset.

(b) Rate of physical adsorption decreases with rise in temperature.

(c) Physical adsorption is multilayered while chemical adsorption is monolayered.

(ii) 2.0 g of charcoal is placed in 100 mL of 0.5 M CH_3COOH to form an adsorbed mono-acidic layer of acetic acid molecules and thereby the molarity of CH_3COOH reduces to 0.49 M. The surface area of charcoal is 3×10^2 m^2 g^{-1}. Calculate the surface area of charcoal adsorbed by each molecule of acetic acid.

SOLUTIONS

1. (b) : Rate = $k[A]$

1.8×10^{-3} mol L^{-1} $min^{-1} = k \times 0.3$ mol L^{-1}

$\therefore \quad k = \frac{1.8 \times 10^{-3}}{0.3 \times 60} = 1 \times 10^{-4}\ s^{-1}$

2. (a) **3. (a)** **4. (c)**

5. (c) : $\Lambda°(ClCH_2COOH)$

$= \Lambda°(ClCH_2COONa) + \Lambda°(HCl) - \Lambda°(NaCl)$

$= 224 + 203 - 38.2 = 388.8$ ohm^{-1} cm^2 g equiv^{-1}

6. (b)

OR

(d)

7. (c) : $\Delta G° = -nFE° = -2 \times 96500 \times [1.23 - (-0.44)]$ J

$= -322310$ J $= -322.31$ kJ

8. (b)

9. (d)

OR

(d)

10. (d) : Magnesium is more electropositive than zinc.

OR

(b) : pH = 10 $\Rightarrow$ $-\log [H^+] = 10$

$E° = 0.059 \log [H^+] = -0.59$ volt

11. (b)

12. (c) : Rubber plating does not involve coagulation process.

13. (c) : Associate colloids decrease surface tension and increase viscosity.

OR

(a) : Longer the carbon chain, *i.e.*, greater the size of the hydrophobic tail, lesser is the solubility in water and greater is the tendency of surfactant molecules to associate to form micelles. Therefore, critical concentration for micelle formation decreases.

14. (d) : Rate of a chemical reaction depends upon temperature, surface area of reactant and concentration of reactant.

15. (d)

16. (d) : When KI solution is added to $AgNO_3$ solution, positively charged sol results due to adsorption of Ag^+ ions from dispersion medium.
When $AgNO_3$ solution is added to KI solution, the precipitated silver iodide adsorbs iodide ions from the dispersion medium and negatively charged sol results.

OR

(a)

17. (c) : Rate of reaction depends upon the experimental conditions such as concentration of reactants, temperature and catalyst. It may or may not be equal to the stoichiometric coefficients of the reacting species in a balanced chemical equation.

18. (b) : On applying external voltage greater than 1.1 V in the Daniell cell, current flows in the reverse direction, *i.e.*, electrons flow from cathode (Cu^{2+}/Cu) to anode (Zn/Zn^{2+}). The reverse reaction takes place as,
$Zn^{2+} + Cu \longrightarrow Zn + Cu^{2+}$

OR

(a)

19. (a) : Such reactions are called pseudo first order reactions.

20. (b) : $Fe^{2+} + 2e^- \rightarrow Fe$;
$E^\circ_{Fe^{2+}/Fe} = x_1$ V
$\Delta G_1 = -nFE_1 = -2x_1F$
$Fe^{3+} + e^- \rightarrow Fe^{2+}$; $E^\circ_{Fe^{3+}/Fe^{2+}} = x_2$ V
$\Delta G_2 = -nFE_2 = -1x_2F$
$Fe^{3+} + 3e^- \rightarrow Fe$; $E^\circ_{Fe^{3+}/Fe} = ?$
$\Delta G_3 = \Delta G_1 + \Delta G_2$
$-nFE_3 = -2x_1F - x_2F \Rightarrow -3E_3 = -2x_1 - x_2$

$$E_3 = \left(\frac{2x_1 + x_2}{3}\right)$$

OR

(c) : According to Nernst equation,

$$E = E^\circ - \frac{0.059}{n}\log Q \text{ at } 25\ ^\circ C$$

At equilibrium, $E = 0$, $Q = K$

$$\therefore \quad 0 = E^\circ - \frac{0.059}{n}\log K \Rightarrow E^\circ = \frac{0.059}{n}\log K$$

$$\log K = \frac{E^\circ \times n}{0.059} \Rightarrow \log K = \frac{0.295 \times 2}{0.059}$$

$$K = \text{antilog}\frac{0.295 \times 2}{0.059} \Rightarrow K = 1 \times 10^{10}$$

21. (c)

22. (a) : $n = \dfrac{80-50}{10} = 3$; $\dfrac{r_{new}}{r_{old}} = (3)^n$

New rate $= 2.6 \times 10^{-3} \times 3^3 = 70.2 \times 10^{-3}$
$= 7.02 \times 10^{-2}$ mol L^{-1} s^{-1}

OR

(d) : From the unit of k, it is evident that it is a second order reaction.

$$-\frac{1}{2}\frac{d[NO_2]}{dt} = \frac{d[O_2]}{dt} \quad \therefore -\frac{d[NO_2]}{dt} = 2 \times \frac{d[O_2]}{dt}$$

$= 2 \times 1.5 \times 10^{-4} = 3 \times 10^{-4}$
$3 \times 10^{-4} = k[NO_2]^2 = 3 \times 10^{-3}[NO_2]^2$
$\therefore \quad [NO_2] = 0.316$

23. (b) : Physical adsorption results into multimolecular layers on adsorbent surface under high pressure. While chemical adsorption results into unimolecular layer.

24. (a) : The initial reaction : $r_1 = [A_1]^\alpha[B_1]^\beta$
When the rate increases by a factor of 100
$\Rightarrow \quad r_2 = [A_2]^\alpha[B_2]^\beta$
Now, $r_2 = 100r_1$, $A_2 = 10A_1$ and $B_2 = B_1$
$\therefore \quad r_1 = [A_1]^\alpha[B_1]^\beta$ and $r_2 = 100r_1 = [10A_1]^\alpha[B_1]^\beta$

$$\therefore \quad \frac{r_1}{r_2} = \frac{1}{100} = \frac{[A_1]^\alpha}{[10A_1]^\alpha} \times \frac{[B_1]^\beta}{[B_1]^\beta}$$

$$\Rightarrow \quad \left(\frac{1}{10}\right)^2 = \left(\frac{1}{10}\right)^\alpha \quad \therefore \quad \alpha = 2$$

Order of reaction with respect to A is 2.

25. (b) : The equation of n^{th} order reaction is

$$k \times t = \frac{1}{n-1}\left[\frac{1}{(a-x)^{n-1}} - \frac{1}{a^{n-1}}\right]$$

The rate constant for zero order reaction ($n = 0$)

$$k = \frac{1}{t \times -1}\left[\frac{1}{(C_t)^{-1}} - \frac{1}{(C_0)^{-1}}\right] \quad (a - x = C_t \text{ and } a = C_0)$$

$$k = \frac{-1}{t}[C_t - C_0]$$

$$k = \frac{C_0 - C_t}{t} \quad \text{[For zero order reaction)}$$

26. (b) : In a chemical reaction, $A \rightarrow B$,

$$\frac{dx}{dt} = k[A]^n \qquad \ldots \text{(i)}$$

Rate of reaction doubles when the concentration of A is increased four times.

$$\frac{dx}{dt} = 2 = k[4A]^n \qquad \ldots \text{(ii)}$$

From (ii) ÷ (i),

$$2 = \left[\frac{4A}{A}\right]^n \Rightarrow \quad 2^1 = 2^{2n} \quad \Rightarrow \quad 2n = 1 \quad \therefore \quad n = 1/2.$$

27. Strong electrolyte has high value of molar conductivity (Λ_m). It increases slightly with dilution of its solution. The plot of Λ_m *vs* $\sqrt{C}$ on extrapolation to $C = 0$, gives a definite value of Λ°_m. Weak electrolyte has low value of molar conductivity (Λ_m). It increases appreciably on dilution of its solution. The plot of Λ_m *vs* $\sqrt{C}$ on extrapolation to $C = 0$, does not give a definite value of Λ°_m because the plot becomes almost parallel to Λ_m axis.

28. (a) Rate of reaction $= \dfrac{-dp_{CH_3CHO}}{dt}$

$= \dfrac{\text{Change in pressure}}{\text{Change in time}} = \dfrac{\text{atmosphere}}{\text{min}} = \text{atm min}^{-1}$

(b) Unit of rate constant k can be obtained as follows.

$$k = \frac{\text{Reaction rate}}{(p_{CH_3CHO})^{3/2}} = \frac{\text{atm}.\,\text{min}^{-1}}{(\text{atm})^{3/2}} = \text{atm}^{-1/2}\ \text{min}^{-1}$$

OR

Let, initial conc. of the reactant = a

Final conc. of the reactant = $\dfrac{1}{16} \times a = \dfrac{a}{16}$

For a first order reaction,

$$k = \frac{2.303}{t}\log\frac{[A_0]}{[A_t]}$$

$$\therefore \quad t = \frac{2.303}{k}\log\frac{a}{a/16} = \frac{2.303}{60\ \text{s}^{-1}}\log 16 = 0.046\ \text{s}$$

29. For first order reaction, $t = \dfrac{2.303}{k}\log\dfrac{[R_0]}{[R_t]}$

For 99% completion of reaction

$t = t_{0.99}$, $[R]_0 = 1$, $[R]_t = (1 - 0.99) = 0.01 = 10^{-2}$

$$t_{0.99} = \frac{2.303}{k}\log\frac{1}{10^{-2}} = \frac{2.303}{k}\log 10^2 = \frac{2.303}{k} \times 2 \qquad ...(i)$$

For 90% completion of reaction

$t = t_{0.90}$, $[R]_0 = 1$, $[R]_t = (1–0.9) = 0.1 = 10^{-1}$

$$t_{0.90} = \frac{2.303}{k}\log\frac{1}{10^{-1}} = \frac{2.303}{k}\log 10 = \frac{2.303}{k} \qquad ...(ii)$$

Comparing equations (i) and (ii),

$t_{0.99} = 2 \times t_{0.90}$

30. (i) Electrode potential is the potential difference set up between metal and its ions in the solution or it is the tendency of an electrode to get oxidised or reduced. When the concentrations of all the species involved in a half-cell is unity then the electrode potential is known as standard electrode potential.

(ii) Platinum adsorbs H_2 where it remains in contact with H^+ ions and thus, it provides surface at which exchange of electrons occurs.

31. According to Freundlich adsorption isotherm,

$$\frac{x}{m} = kP^{1/n} \qquad ...(i)$$

or $\log\dfrac{x}{m} = \log k + \dfrac{1}{n}\log P$

Plot of $\log\left(\dfrac{x}{m}\right)$ *vs* log P is linear with slope $= \dfrac{1}{n}$ and intercept = log k.

Thus, slope $= \dfrac{1}{n} = \tan 45^\circ = 1$

$\therefore \quad n = 1$

Intercept log $k = 0.3010$

or $k = 2$

$\therefore \quad \dfrac{x}{m} = kP^{1/n} = 2 \times (0.5)^1 = 1.0$

OR

S. No.	Multimolecular Colloids	Macromolecular colloids
1.	When a large number of small molecules or atoms (diameter < 1 nm) of a substance combine together in a dispersion medium to form aggregates, having size in the colloidal range, the colloidal solutions thus, formed are known as multimolecular colloids.	When substances which possess very high molecular masses are dispersed in suitable dispersion medium, the colloidal solutions thus, formed are called macromolecular colloids.
2.	*e.g.*, gold sol, sulphur sol, etc.	*e.g.*, cellulose, starch, etc.

Associated colloids : The substances which at low concentration, behave as normal strong electrolytes but at higher concentration exhibit colloidal behaviour due to the formation of aggregated particles, are known as associated colloids.

32. (a) Ions (either +ve or –ve) of peptising agent (electrolyte) are adsorbed on the particles of the precipitate. They repel and hit each other breaking the particles of the precipitate into colloidal size.

(b) It neutralizes the charge on the carbon particles which get precipitated and thus gases entering into chimney are free from carbon particles.

(c) This is done because gold particles have large surface rea and easily assimilated into blood which is colloidal.

33. At anode : $Al_{(s)} \rightarrow Al^{3+}_{(aq)} + 3e^-] \times 2$

At cathode : $Ni^{2+} + 2e^- \rightarrow Ni_{(s)}] \times 3$

Cell reaction : $2Al_{(s)} + 3Ni^{2+}_{(aq)} \rightarrow 2Al^{3+}_{(aq)} + 3Ni_{(s)}$

Applying Nernst equation to the above cell reaction,

$$E_{cell} = E^\circ_{cell} - \frac{0.0591}{2\times 3}\log\frac{[Al^{3+}]^2}{[Ni^{2+}]^3}$$

Now, $E^\circ_{cell} = E^\circ_{Ni^{2+}/Ni} - E^\circ_{Al^{3+}/Al}$

$= -0.25\ V - (-1.66) = 1.41\ V$

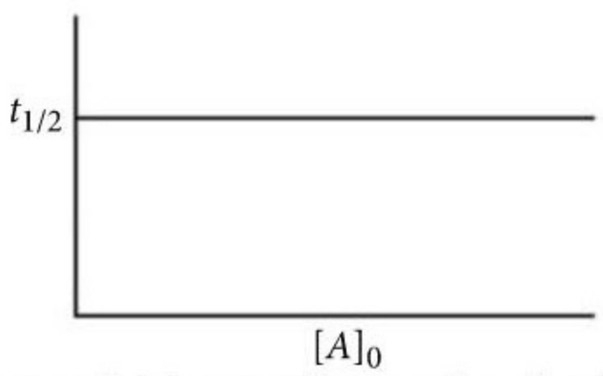
$$\therefore \quad E_{cell} = 1.41\ V - \frac{0.0591}{6}\log\frac{(10^{-3})^2}{(0.5)^3}$$

$$= 1.41\ V - \frac{0.0591}{6}\log(8\times 10^{-6})$$

$$= 1.41\ V - \frac{0.0591}{6}(5.09) \quad = 1.41V + 0.050\ V = 1.46\ V$$

34. (i) For first order reaction, $t_{1/2} = \frac{0.693}{k}$

Curve between $t_{1/2}$ and $[A]_0$ for 1st order reaction is drawn as



(ii) The reactions which are of second order but behave like first order reactions are called pseudo first order reactions *e.g.*, during hydrolysis of ethyl acetate (ester) with water, the concentration of water does not alter much during the reaction. So, in the rate equation the concentration of water (the reactant which is in excess) can be taken as constant hence, the reaction behaves as first order reaction.

$$CH_3COOC_2H_5 + H_2O \xrightarrow{H^+} CH_3COOH + C_2H_5OH$$

Rate $= k'[CH_3COOC_2H_5][H_2O]$, the term $[H_2O]$ can be taken as constant. Hence, the rate equation becomes Rate $= k[CH_3COOC_2H_5]$ where $k = k'[H_2O]$

35. (i) $k = \frac{2.303}{t}\log\frac{[A]_0}{[A]}$

$[A]_0 = 10$ g, $[A] = 0.25$ g, $t = 5$ years

$$k = \frac{2.303}{5}\log\frac{10}{0.25} = \frac{2.303}{5}\log 40 = 0.7379\ \text{year}^{-1}$$

(ii) $t = 1$ year, $[A]_0 = 10$ g, $[A] = ?$

$$k = \frac{2.303}{t}\log\frac{[A]_0}{[A]}$$

$$0.7379 = \frac{2.303}{1}\log\frac{10}{[A]}$$

$$\log\frac{10}{[A]} = \frac{0.7379\times 1}{2.303} = 0.3204$$

$$\frac{10}{[A]} = \text{Antilog}\ (0.3204) = 2.09 \quad \therefore \quad [A] = \frac{10}{2.09} = 4.785\ \text{g}$$

(iii) Time for decay of half of the element,

$$t_{1/2} = \frac{0.693}{k} = \frac{0.693}{0.7379} = 0.9392\ \text{year}$$

OR

(i) Rate law may be written as :

Rate $= k[A]^a[B]^b[C]^c$

Comparing experiments 1 and 2,

$(\text{Rate})_1 = k(0.02)^a(0.02)^b(0.02)^c = 2.08\times 10^{-3}$ ...(i)

$(\text{Rate})_2 = k(0.01)^a(0.02)^b(0.02)^c = 1.04\times 10^{-3}$ ...(ii)

Dividing eq. (i) by eq. (ii) we get,

$$\frac{(\text{Rate})_1}{(\text{Rate})_2} = \frac{(0.02)^a}{(0.01)^a} = \frac{2.08\times 10^{-3}}{1.04\times 10^{-3}} = 2$$

or $2^a = 2 \quad \therefore \quad a = 1$

Comparing experiments 1 and 3,

$(\text{Rate})_1 = k(0.02)^a(0.02)^b(0.02)^c = 2.08\times 10^{-3}$ ...(iii)

$(\text{Rate})_3 = k(0.02)^a(0.04)^b(0.02)^c = 4.16\times 10^{-3}$ ...(iv)

Dividing eq. (iv) by eq. (iii) we get,

$$\frac{(\text{Rate})_3}{(\text{Rate})_1} = \frac{(0.04)^b}{(0.02)^b} = \frac{4.16\times 10^{-3}}{2.08\times 10^{-3}} = 2$$

$$2^b = 2 \quad \therefore \quad b = 1$$

Comparing experiments 1 and 4,

$(\text{Rate})_1 = k(0.02)^a(0.02)^b(0.02)^c = 2.08\times 10^{-3}$ ...(v)

$(\text{Rate})_4 = k(0.02)^a(0.02)^b(0.04)^c = 8.32\times 10^{-3}$ ...(vi)

Dividing eq. (vi) by eq. (v), we get

$$\frac{(\text{Rate})_4}{(\text{Rate})_1} = \frac{(0.04)^c}{(0.02)^c} = \frac{8.32\times 10^{-3}}{2.08\times 10^{-3}} = 4$$

or $2^c = 2^2 \quad \therefore \quad c = 2$

Therefore, the order of the reaction with respect to A, B and C are 1, 1 and 2 respectively.

Rate $= k[A][B][C]^2$

(ii) Substituting the values from expt. 1, we get

$$2.08\times 10^{-3} = k\times 0.02\times 0.02\times (0.02)^2$$

$$\therefore \quad k = \frac{2.08\times 10^{-3}}{(0.02)^4} = \frac{2.08\times 10^{-3}}{16\times 10^{-8}} = 1.3\times 10^4\ \text{M}^{-3}\ \text{min}^{-1}$$

(iii) Rate of reaction when concentration of all reactants $= 0.01$ M

Rate $= 1.3\times 10^4\times(0.01)\times(0.01)\times(0.01)^2$

$= 1.3\times 10^{-4}$ M min^{-1}

36. (a) For the equation,

$M^{n+}_{(aq)} + ne^- \rightarrow M_{(s)}$

$$E_{cell} = E^\circ_{cell} - \frac{2.303RT}{nF}\log\frac{1}{\left[M^{n+}_{(aq)}\right]}$$

$$= E^\circ_{cell} - \frac{0.059}{n}\log\frac{1}{\left[M^{n+}_{(aq)}\right]}$$

(b) (i) $Mg_{(s)} \mid Mg^{2+}(0.001\ M) \parallel Cu^{2+}(0.0001M) \mid Cu_{(s)}$

At anode : $Mg_{(s)} \longrightarrow Mg^{2+}_{(aq)} + 2e^-$

At cathode : $Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$

Net cell reaction :

$Mg_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Mg^{2+}_{(aq)} + Cu_{(s)}$

$\therefore \quad n = 2$

Using Nernst equation,

$$E_{cell} = E^\circ_{cell} - \frac{2.303\ RT}{nF} \log \frac{[Mg^{2+}]}{[Cu^{2+}]}$$

For the given cell,

$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode} = E^\circ_{Cu2+/Cu} - E^\circ_{Mg2+/Mg}$

$= 0.34 - (-2.37) = 2.71$ V

Given : $[Mg^{2+}] = 0.001$ M, $[Cu^{2+}] = 0.0001$ M

Putting values in Nernst equation at 298 K,

$$E_{cell} = 2.71 - \frac{0.059}{2} \log \frac{0.001}{0.0001}$$

$E_{cell} = 2.71 - 0.0295 \log 10 = 2.71 - 0.03 = 2.68$ V

(ii) $Fe_{(s)} \mid Fe^{2+}(0.001\ M) \parallel H^+(1\ M) \mid H_{2(g)}(1\ bar) \mid Pt_{(s)}$

At anode : $Fe_{(s)} \longrightarrow Fe^{2+}_{(aq)} + 2e^-$

At cathode : $2H^+_{(aq)} + 2e^- \longrightarrow H_{2(g)}$

Cell reaction : $Fe_{(s)} + 2H^+_{(aq)} \longrightarrow Fe^{2+}_{(aq)} + H_{2(g)}$

$\therefore \quad n = 2$

Using Nernst equation at 298 K,

$$E_{cell} = E^\circ_{cell} - \frac{0.0591}{2} \log \frac{[Fe^{2+}] \times p_{H_2}}{[H^+]^2}$$

For the given cell,

$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode} = E^\circ_{H^+/H2} - E^\circ_{Fe2+/Fe}$

$= 0 - (-0.44) = +0.44$ V

Given : $[Fe^{2+}] = 0.001$ M; $[H^+] = 1$ M; $p_{H2} = 1$ bar

Putting values in Nernst equation,

$$E_{cell} = 0.44 - 0.0295 \log \frac{0.001 \times 1}{1^2}$$

$= 0.44 - 0.0295 \log 10^{-3} = 0.44 - [(0.0295) \times (-3)]$

$= 0.44 + 0.0885 = 0.53$ V

OR

(a) Water is a weak electrolyte, hence Λ°_m value of water is determined using Kohlrausch law.

$\Lambda^\circ_m (H_2O) \longrightarrow \lambda^\circ_m(H^+) + \lambda^\circ_m(OH^-)$

It can be determined by knowing the Λ°_m of three electrolytes HCl, NaOH and NaCl.

Applying Kohlrausch law,

$\Lambda^\circ_m(H_2O) \longrightarrow \Lambda^\circ_m(HCl) + \Lambda^\circ_m(NaOH) - \Lambda^\circ_m (NaCl)$

(b) Given, $\lambda^\circ_m(H^+) = 349.6\ S\ cm^2\ mol^{-1}$

$\lambda^\circ_m (HCOO^-) = 54.6\ S\ cm^2\ mol^{-1}$

$\Lambda^c_m (HCOOH) = 46.1\ S\ cm^2\ mol^{-1}$

$\alpha = ?$

From Kohlrausch law,

$\Lambda^\circ_m (HCOOH) = \lambda^\circ_m(H^+) + \lambda^\circ_m(HCOO^-)$

or $\Lambda^\circ_m(HCOOH) = 349.6\ S\ cm\ mol^{-1} + 54.6\ S\ cm^2\ mol^{-1}$

$= 404.2\ S\ cm^2\ mol^{-1}$

Using formula

$$\alpha = \frac{\Lambda^c_m}{\Lambda^\circ_m} = \frac{46.1\ S\,cm^2\ mol^{-1}}{404.2\ S\,cm^2\ mol^{-1}} = 0.114$$

$$\text{Again, } K_a = \frac{\alpha^2 C}{1-\alpha}$$

$$= \frac{(0.114)^2 \times 0.025\ mol\ L^{-1}}{1-0.114} = 3.67 \times 10^{-4}$$

37. (i) (a) Multimolecular colloid, because sulphur molecules associate together to form colloidal sol.

(b) Macromolecular colloid, because protein molecules present in the white of an egg are macromolecules soluble in water.

(c) Associated colloid, because $RCOO^-$ ions associate together to form micelles.

(ii) (a) Colloidal particles of test tube (*A*) are positively charged whereas colloidal particles of test tube (*B*) are negatively charged.

(b) In test tube (*A*), Fe^{3+} is adsorbed on the precipitate $Fe_2O_3 \cdot xH_2O$ [or $Fe_2O_3 \cdot xH_2O/Fe^{3+}$ is formed].

In test tube (*B*), OH^- ion is adsorbed on the precipitate $Fe_2O_3 \cdot xH_2O$ [or $Fe_2O_3 \cdot xH_2O/OH^-$ is formed].

OR

(i) (a) At the time of sunset, the sun is at horizon. The light emitted by the sun has to travel a relatively longer distance through the atmosphere. As a result, blue part of light is scattered away by the particulate in the atmosphere causing red part to be visible.

(b) Gas (adsorbate) + Solid (adsorbent) $\underset{\text{Evaporation}}{\overset{\text{Condensation}}{\rightleftharpoons}}$ Gas adsorbed on solid + Heat

Physical adsorption is an exothermic process. According to Le-Chatelier's principle, at equilibrium as the temperature is increased, the equilibrium shifts in the backward direction, *i.e.*, adsorption decreases.

(c) Physical adsorption involves van der Waals' forces, so any number of layers may be formed one over the other on the surface of the adsorbent. Chemical adsorption takes place as a result of the reaction between adsorbent and adsorbate. When the surface of adsorbent is covered with one layer, no further reaction can take place.

(ii) CH_3COOH adsorbed $= 0.5 - 0.49 = 0.01$ M

Number of molecules adsorbed

$$= 0.01 \times \frac{100}{1000} \times 6 \times 10^{23} = 6 \times 10^{20}$$

Total area of charcoal $= 2\ g \times 3 \times 10^2\ m^2\ g^{-1} = 600\ m^2$

$$\therefore \quad \text{Area per molecule} = \frac{600}{6 \times 10^{20}} = 1 \times 10^{-18}\ m^2$$

CLASS-XI

BRUSH UP for NEET/JEE

Brush up your concepts to get high rank in NEET/JEE (Main and Advanced) by reading this column. This specially designed column is updated year after year by a panel of highly qualified teaching experts well-tuned to the requirements of these Entrance Tests.

2021

Unit 2

Classification of Elements and Periodicity in Properties | Chemical Bonding and Molecular Structure

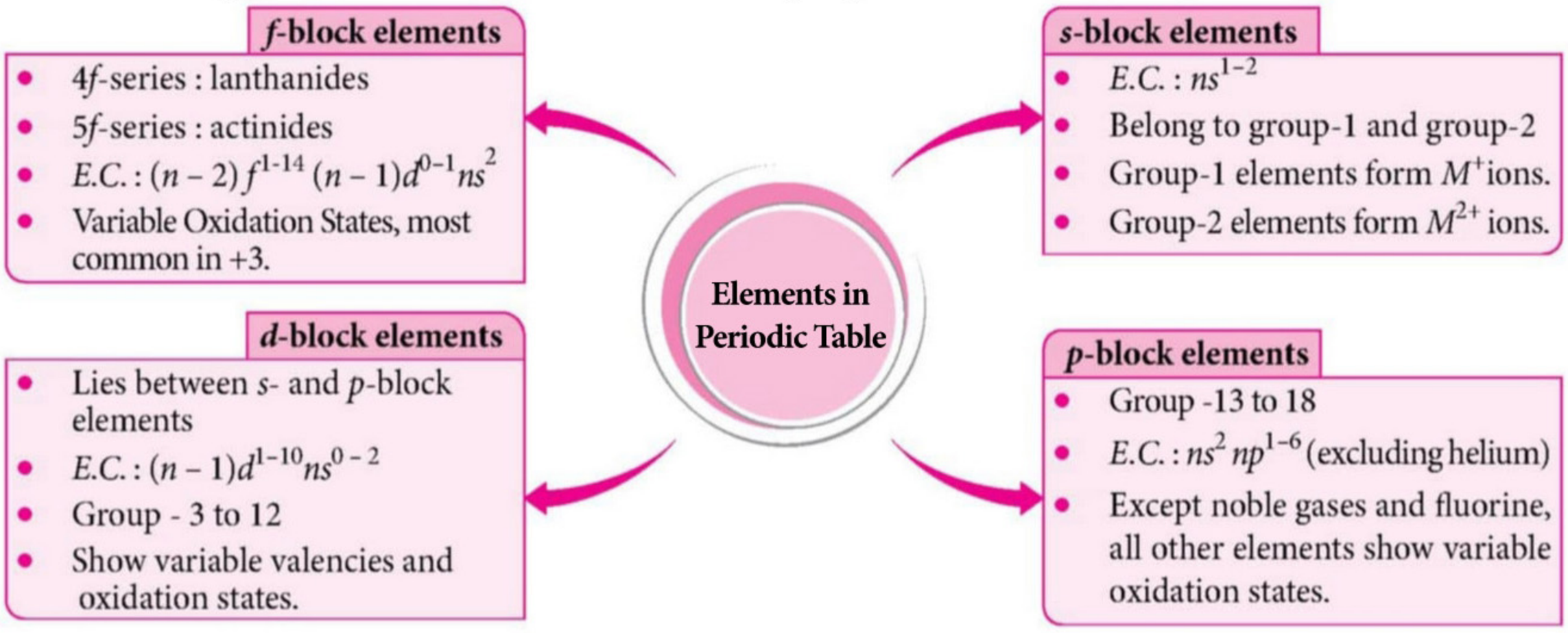
Classification of Elements and Periodicity in Properties

Modern Periodic Law

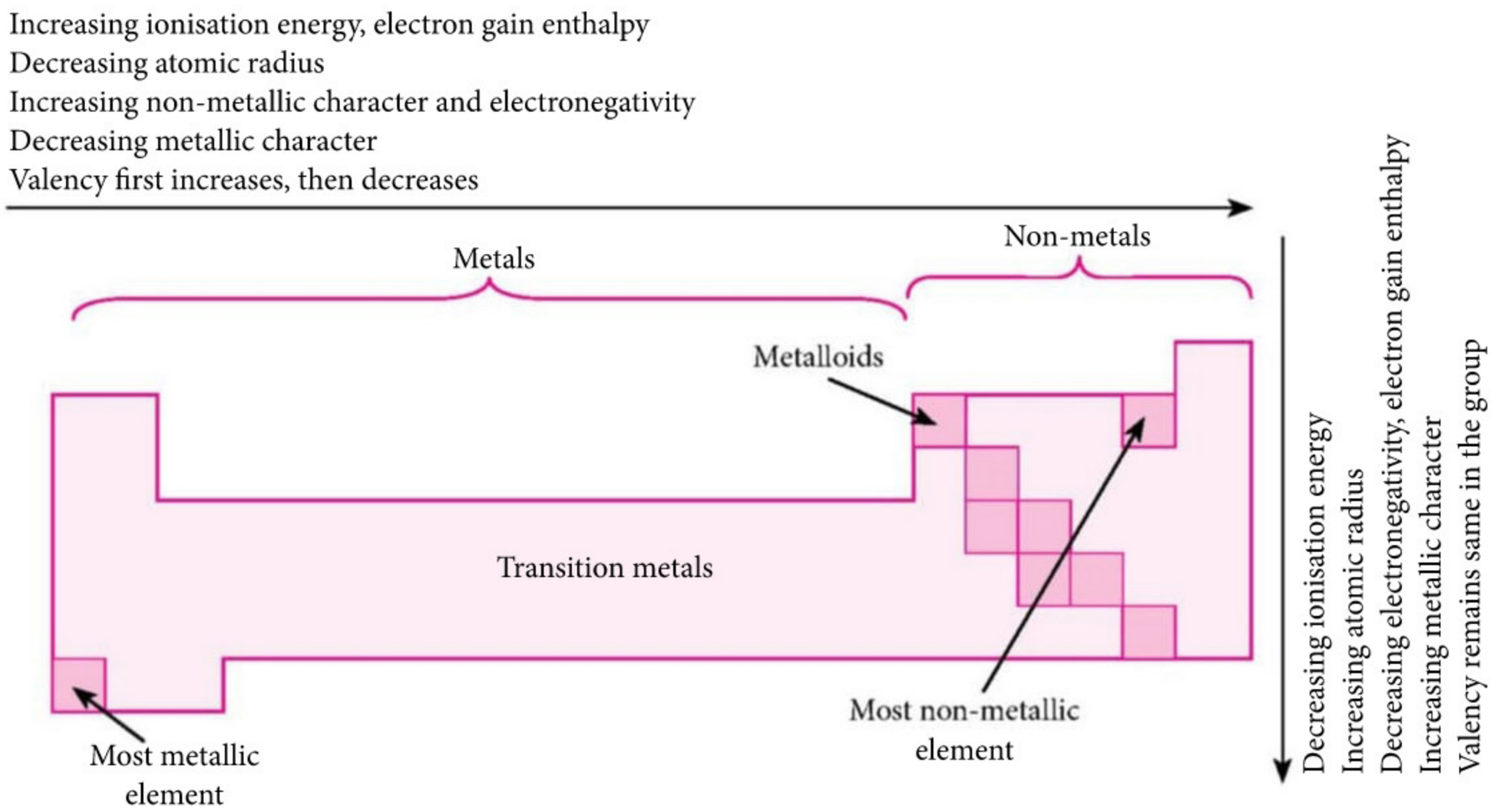
- The physical and chemical properties of elements are periodic function of their atomic numbers.
- Periodic function is due to repetition of similar outer electronic configuration after certain regular intervals.

Features of Modern Periodic Table

- Elements are arranged in order of increasing atomic numbers.
- It has seven horizontal rows known as periods.
- There are eighteen vertical columns which are called groups or families.



Trends in Properties of Elements



Ionic Radius

- The effective distance from the centre of nucleus of an ion upto which it has an influence on its electron cloud is called its ionic radius.

$$d_{(a^+ - b^-)} = r_{a^+} + r_{b^-}$$

Radii of isoelectronic ions,

$$r_{anion} > r_{neutral} > r_{cation}$$

$$\text{Ionic radius} \propto \frac{1}{\text{Effective nuclear charge}}$$

Ionisation Enthalpy

- The amount of energy required to remove the most loosely bounded electrons from an isolated gaseous atom in its ground state, is called ionisation enthalpy

$$M_{(g)} \xrightarrow{\text{Energy}} M^+_{(g)} + e^-$$

$$\text{Ionisation energy} \propto \frac{1}{\text{Size of atom}} \propto \text{Effective nuclear charge} \propto \frac{1}{\text{Screening effect}}$$

$$\underset{\text{energy}}{\text{First ionisation}} < \underset{\text{energy}}{\text{Second ionisation}} < \underset{\text{energy}}{\text{Third ionisation}}$$

Electron Gain Enthalpy

- It is the molar enthalpy change when an neutral isolated gaseous atom in its ground state gains an electron to form the corresponding anion.

$$X_{(g)} + e^- \longrightarrow X^-_{(g)}$$

For elements with stable electronic configuration, electron gain enthalpy is zero or nearly zero.

Electronegativity

- The relative tendency of an atom in a molecule to attract the shared pair of electrons towards itself in a covalent bond is termed as electronegativity.

$$E.N. \propto \frac{1}{\text{Atomic size}} \propto I.E.$$

Flourine is most electronegative atom.

- Mulliken scale of electronegativity,

$$\chi = \frac{1}{2}[\Delta_i H + \Delta_{eg} H]$$

- Pauling scale of electronegativity,

$$\chi_A - \chi_B = 0.1017\sqrt{\Delta}$$

where, $\Delta = E_{A-B} - \frac{1}{2}\sqrt{E_{A-A} + E_{B-B}}$

here, E represents bond dissociation enthalpy (kJ mol^{-1}).

Mythological reference!

There are 15 elements named after a mythological character or reference. Thorium and vanadium are named after Norse God of war 'Thor' and Goddess of beauty 'Vanadis', respectively. Helium is named after the Sun God 'Helios', irridium after Goddess of rainbow 'Iris', and titanium after the 'Titans'.

Chemical Bonding and Molecular Structure

Types of Bonds

Bonds

Ionic bond

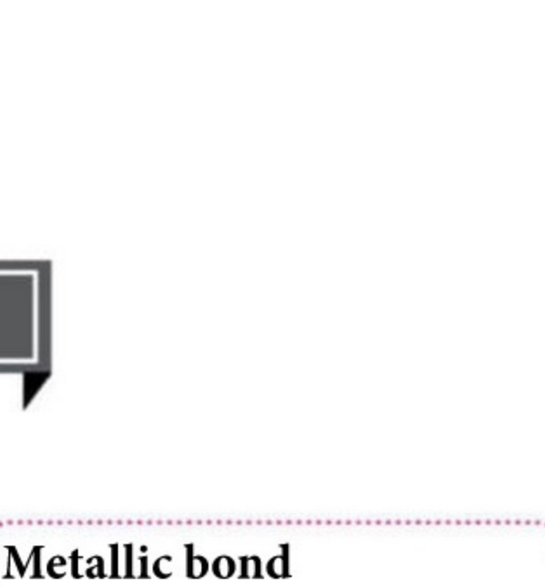
Electrostatic attraction between a cation (metal) and an anion (non-metal).

Coordinate bond

Coordinate bonds are formed between electron deficient molecules or ions (Lewis acids) and electron rich molecules or ions (Lewis bases).

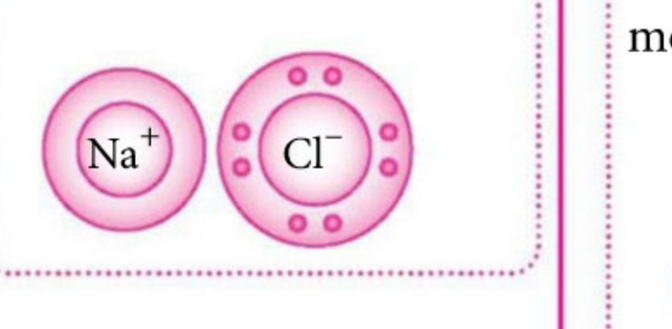
Metallic bond

Attraction between mobile electrons and positively charged metallic atoms.



Hydrogen bond

Bond between H-atom and electronegative elements (like N, O, F)



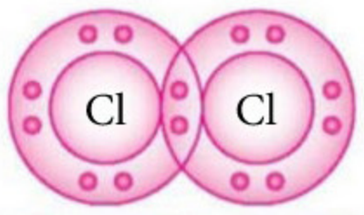
Intermolecular
e.g., HF, H_2O

Intramolecular
e.g., *o*-Nitrophenol

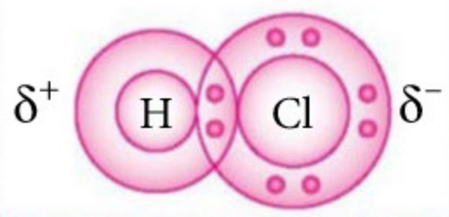
Covalent bond

Bond between non-metal atoms due to sharing of electron pairs.

Non-polar covalent



Polar covalent



- **Formal charge on an atom** = Total number of valence electrons in an atom – Total number of lone pairs of electrons – $\frac{1}{2}$ (Total number of shared electrons).

VSEPR Theory

- It states that bonded atoms in a molecule adopt that particular arrangement in space, in which electron pairs surrounding the central atom repel one another and go far apart so, there are no further repulsions.
- The magnitude of repulsion is : *lp* – *lp* > *lp* – *bp* > *bp* – *bp*
- Shape of the molecule is determined by this theory.

Geometry Based on VSEPR Theory

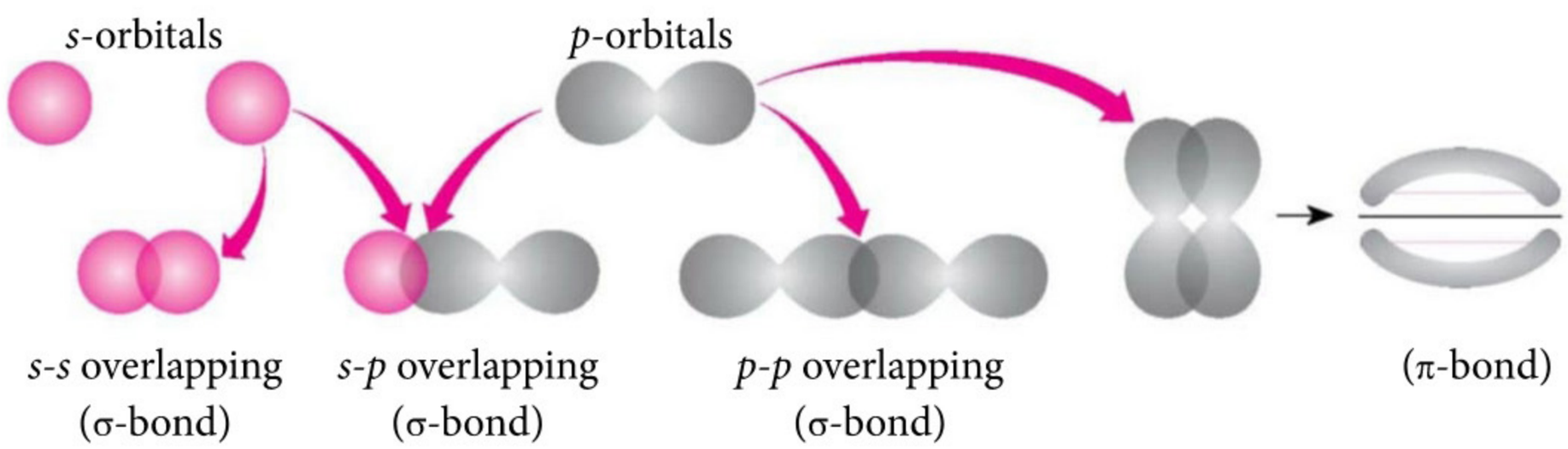
Total number of electron pairs	Molecular formula	Geometry	Bond angle	Example
2	AX_2	Linear	180°	$BeCl_2$
3	AX_3 AX_2E	Trianglar planar Bent (V-shape)	120° 119°	BF_3 SO_2

4	AX_4 AX_3E AX_2E_2	Tetrahedral Trigonal pyramidal Bent	109°28′ 107°48′ 104°27′	CH_4, SiH_4 NH_3 H_2O
5	AX_5 AX_4E AX_3E_2 AX_2E_3	Trigonal bipyramidal Irregular tetrahedral (Sea saw) T-shaped Linear	120 and 90° 101°36′ and 86°33′ 87°40′ 180°	PCl_5 SF_4 and IF_4^+ ClF_3 I_3^-
6	AX_6 AX_5E AX_4E_2	Octahedral Square pyramidal Square planar	90° 84° 30′ 90°	SF_6 BrF_5 XeF_4
7	AX_7	Pentagonal bipyramidal	72° 90′	IF_7

Valence Bond Theory (VBT)

- The formation of covalent bond is due to pairing of electrons present in the valence shell having opposite spin.

Overlapping of Atomic Orbitals



Hybridisation

- The intermixing of atomic orbitals of same energy or slightly different energy to produce entirely new sets of orbitals of equivalent energies and identical shapes.
- The structure of any molecule can be predicted on the basis of hybridisation by using formula :

$$\text{No. of hybrid orbitals } (H) = \frac{1}{2}\left[\begin{pmatrix}\text{No. of valence}\\ \text{electrons of}\\ \text{central atom}\end{pmatrix} + \begin{pmatrix}\text{No. of}\\ \text{monovalent}\\ \text{atoms}\end{pmatrix} - \begin{pmatrix}\text{Charge}\\ \text{present}\\ \text{on the}\\ \text{cation}\end{pmatrix} + \begin{pmatrix}\text{Charge}\\ \text{present}\\ \text{on the}\\ \text{anion}\end{pmatrix}\right]$$

$$\Rightarrow \quad H = \frac{1}{2}[V + M - c + a]$$

Molecular Orbital Theory (MOT)

- Atomic orbitals of comparable energies combine to form molecular orbitals.
- The number of molecular orbitals formed is equal to the number of combining atomic orbitals.
- When two atomic orbitals combine, two molecular orbitals are formed, one with lower energy (bonding molecular orbital) another with high energy (antibonding molecular orbital).

INFO SHOTS

Chemical bonding in metal borides!

Ultrahard materials, such as TiB_2, ReB_2 and OsB_2 are being developed as potential lower cost alternatives to diamond, carbides and boron-nitride that are traditionally used for cutting, drilling and polishing tools.

Order of Energy

- For O_2 and F_2,
  $\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \sigma 2p_z < \pi 2p_x = \pi 2p_y < \pi^* 2p_x = \pi^* 2p_y < \sigma^* 2p_z$
- For Li_2 to N_2,
  $\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \pi 2p_x = \pi 2p_y < \sigma 2p_z < \pi^* 2p_x = \pi^* 2p_y < \sigma^* 2p_z$
- Bond order $= \frac{1}{2}(N_b - N_a)$

  $\because$ N_b = Number of electrons in bonding molecular orbitals,

  N_a = Number of electrons in antibonding molecular orbitals.
- Bond strength $\propto$ Bond order $\propto \frac{1}{\text{Bond length}}$

WRAP it up!

1. Anhydrous $AlCl_3$ is covalent but hydrated $AlCl_3.6H_2O$ is ionic because
(a) $AlCl_3$ dissolves in CS_2
(b) $AlCl_3$ has planar structure
(c) *I.E.* of Al is low
(d) hydration energy of Al compensates the *I.E.*

2. If the magnetic moment of a dioxygen species is 1.73 B.M. it may be
(a) O_2, O_2^- or O_2^+ (b) O_2^- or O_2^+
(c) O_2 or O_2^- (d) O_2 or O_2^+

3. The correct order for bond angle in following is
(a) $NH_2^- > NH_3 > NH_4^+$
(b) $NH_4^+ > NH_2^- > NH_3$
(c) $NH_4^+ > NH_3 > NH_2^-$
(d) $NH_3 > NH_4^+ > NH_2^-$

4. Ionic radii of
(a) $Ti^{4+} < Mn^{2+}$ (b) $^{35}Cl^- < {}^{37}Cl^-$
(c) $K^+ > Cl^-$ (d) $P^{3+} > P^{5+}$

5. The species in which the N atom is in a state of *sp* hybridisation is
(a) NO_2^+ (b) NO_2^-
(c) NO_3^- (d) NO_2 **(JEE Main 2016)**

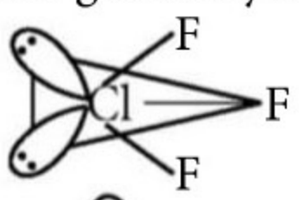
6. Consider the following statements :
1. Cs^+ is more highly hydrated than the other alkali metal ions.
2. Among the alkali metals Li, Na, K and Rb, lithium has the highest melting point.
3. Among the alkali metals only lithium forms a stable nitride by direct combination.

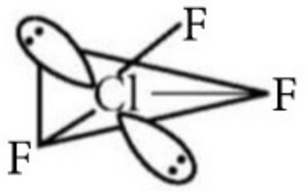
Out of these statements
(a) 1, 2 and 3 are correct
(b) 1 and 2 are correct
(c) 1 and 3 are correct
(d) 2 and 3 are correct.

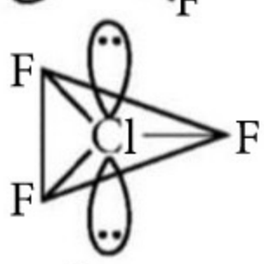
7. Which of the following is the correct order of dipole moment ?
(a) $NH_3 < BF_3 < NF_3 < H_2O$
(b) $BF_3 < NF_3 < NH_3 < H_2O$
(c) $BF_3 < NH_3 < NF_3 < H_2O$
(d) $H_2O < NF_3 < NH_3 < BF_3$ **(Odisha NEET 2019)**

8. The electronic configuration of the element is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$. What is the atomic number of the element which is just below the above element in the periodic table?
(a) 33 (b) 34 (c) 31 (d) 49

9. Which geometry of ClF_3 is more stable ?

1. 

2. 

3. 

(a) Only 2, 3 (b) Only 1
(c) Only 3 (d) Only 2

10. Among the following the lowest degree of paramagnetism per mole of the compound at 298 K will be shown by
(a) $MnSO_4.4H_2O$ (b) $CuSO_4.5H_2O$
(c) $FeSO_4.6H_2O$ (d) $NiSO_4.6H_2O$

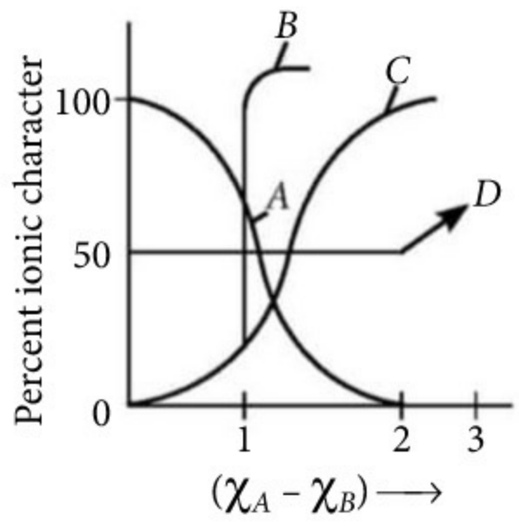
11. CO is practically non-polar since
(a) the σ-electron drift from C to O is almost nullified by the π-electron drift from O to C
(b) the σ-electron drift from O to C is almost nullified by the π-electron drift from C to O
(c) the bond moment is low
(d) there is a triple bond between C and O.

12. Which represents alkali metals, based on $(I.E.)_1$ and $(I.E.)_2$ values?

	$(I.E.)_1$	$(I.E.)_2$
(a) X	100	110
(b) Y	95	120
(c) Z	195	500
(d) M	200	250

13. The correct order of atomic radii in group 13 elements is
(a) B < Al < In < Ga < Tl
(b) B < Al < Ga < In < Tl
(c) B < Ga < Al < Tl < In
(d) B < Ga < Al < In < Tl **(NEET 2018)**

14. For *AB* bond, if percent ionic character is plotted against electronegativity difference $(\chi_A - \chi_B)$, the shape of the curve would look like



The correct curve is
(a) *A* (b) *B* (c) *C* (d) *D*

15. Electron affinity of the following element is
1. $1s^2, 2s^2, 2p^5$ 2. $1s^2, 2s^2, 2p^6, 3s^2, 3p^5$
3. $1s^2, 2s^2, 2p^3$ 4. $1s^2, 2s^2, 2p^6$
(a) 1 > 2 > 3 > 4 (b) 2 > 1 > 3 > 4
(c) 4 > 3 > 2 > 1 (d) 2 > 3 > 1 > 4

16. In general, the properties that decrease and increase down a group in the periodic table, respectively are
(a) atomic radius and electronegativity
(b) electronegativity and electron gain enthalpy
(c) electronegativity and atomic radius
(d) electron gain enthalpy and electronegativity.
(JEE Main 2019)

17. Which of the following statements are true?
1. PH_5 and $BiCl_5$ do not exist.
2. $p\pi - d\pi$ bond is present in SO_2.
3. I_3^+ has bent geometry.
4. SeF_4 and CH_4 have same shape.
(a) 1, 2, 3 (b) 1, 3
(c) 1, 3, 4 (d) 1, 2, 4

18. Consider the following changes :
$A \rightarrow A^+ + e^-; E_1$ and $A^+ \rightarrow A^{2+} + e^-; E_2$
The energy required to pull out 1st and 2nd electrons are E_1 and E_2 respectively. The correct relationship between two energies would be
(a) $E_1 < E_2$ (b) $E_1 = E_2$
(c) $E_1 > E_2$ (d) $E_1 \geq E_2$

19. Polarising action of Cd^{2+} on anions is stronger than that of Ca^{2+} because
(a) the charges of the ions are same
(b) their radii are same (Ca^{2+} = 0.104 nm; Cd^{2+} = 0.99 nm)
(c) the Ca^{2+} ion has a noble gas electronic configuration, and the Cd^{2+} ion, an 18-electronic configuration of its outer shell
(d) all of the above are correct.

20. *AB* is predominantly ionic as $A^+ B^-$ if
(a) $(I.E.)_A < (I.E.)_B$ (b) $(I.E.)_A < (E.A.)_B$
(c) $(E.N.)_A < (E.N.)_B$ (d) $(I.E.)_B < (I.E.)_A$

21. sp^3d^2 hybridisation is not displayed by
(a) SF_6 (b) PF_5
(c) $[CrF_6]^{3-}$ (d) BrF_5
(JEE Main 2017 Online)

22. According to molecular orbital theory, which of the following is true with respect to Li_2^+ and Li_2^-?
(a) Both are stable.
(b) Both are unstable.
(c) Li_2^+ is unstable and Li_2^- is stable.
(d) Li_2^+ is stable and Li_2^- is unstable.
(JEE Main 2019)

23. In which pair or pairs is the stronger bond found in the first species?
I : O_2^{2-}, O_2; II : N_2, N_2^+; III : NO^+, NO^-
(a) I only (b) II only
(c) I and III only (d) II and III only

24. Out of N_2O, SO_2, I_3^+, I_3^-, H_2O, NO_2^-, and N_3^-, the linear species are
(a) NO_2^-, I_3^+, H_2O (b) N_2O, I_3^+, N_3^-
(c) N_2O, I_3^-, N_3^- (d) N_3^-, I_3^+, SO_2

25. The element $Z = 114$ has been discovered recently. It will belong to which of the following family/group and electronic configuration?

(a) Carbon family, [Rn] $5f^{14}\ 6d^{10}\ 7s^2\ 7p^2$

(b) Oxygen family, [Rn] $5f^{14}\ 6d^{10}\ 7s^2\ 7p^4$

(c) Nitrogen family, [Rn] $5f^{14}\ 6d^{10}\ 7s^2\ 7p^6$

(d) Halogen family, [Rn] $5f^{14}\ 6d^{10}\ 7s^2\ 7p^5$

(NEET 2017)

26. The molecule may be represented by three resonating structures having energies E_1, E_2 and E_3 respectively. The energy follows the order $E_3 > E_2 > E_1$. If the actual energy content of the molecules is (E_0). The resonance energy is

(a) $E_2 - E_0$ (b) $E_1 - E_0$

(c) $(E_1 + E_2 + E_3) - E_0$ (d) $E_3 - E_0$

27. Energy of an electron in the ground state of the hydrogen atom is -218×10^{-18} J. The ionisation enthalpy of atomic hydrogen is

(a) $4.314 \times 10^6\ J\ mol^{-1}$ (b) $2.52 \times 10^{-6}\ J\ mol^{-1}$

(c) $1.313 \times 10^6\ J\ mol^{-1}$ (d) $2.33 \times 10^5\ J\ mol^{-1}$

28. Assuming $2s$-$2p$ mixing is not operative, the paramagnetic species among the following is

(a) Be_2 (b) B_2 (c) C_2 (d) N_2

(JEE Advanced 2017)

29. An elements which belong to 3^{rd} period and 14^{th} group, has electronic configuration

(a) $1s^2, 2s^2, 2p^6, 3s^2$ (b) $1s^2, 2s^2, 2p^6, 3s^2, 3p^2$

(c) $1s^2, 2s^2, 2p^6, 3s^2, 3p^3$

(d) $1s^2, 2s^2, 2p^3$

30. Which one of the following compounds shows the presence of intramolecular hydrogen bond?

(a) H_2O_2 (b) HCN

(c) Cellulose

(d) Concentrated acetic acid. **(NEET-II 2016)**

SOLUTIONS

1. (d): $AlCl_3$ is covalent in solid or gaseous state. In polar solvents, it becomes ionic due to high heat of hydration ($\because$ Al has high +3 charge) and it exists as $[Al(H_2O)_6]^{3+}$ and Cl^-.

2. (b): Magnetic moment $(\mu) = \sqrt{n(n+2)}$

$(1.73)^2 = n(n+2) \Rightarrow n = 1$

Electronic configuration of

$O_2 = \sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \sigma 2p_z^2\ \pi 2p_x^2 = \pi 2p_y^2\ \pi^* 2p_x^1 = \pi^* 2p_y^1$

$O_2^- = \sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \sigma 2p_z^2\ \pi 2p_x^2 = \pi 2p_y^2\ \pi^* 2p_x^2 = \pi^*\ 2p_y^1$

$O_2^+ = \sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \sigma 2p_z^2\ \pi 2p_x^2 = \pi 2p_y^2\ \pi^* 2p_x^1$

As O_2^- and O_2^+ has one unpaired electron, therefore these species have magnetic moment = 1.73 B.M.

3. (c): NH_4^+ : sp^3 hybridisation, 109°28′

$\ddot{N}H_3$: sp^3 hybridisation, 107°48′ due to *bp-lp* repulsion

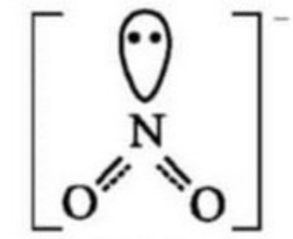
NH_2^- : sp^3 hybridisation, 104°27′ due to *lp-lp* repulsion

$\therefore$ Order for bond angle is $NH_4^+ > NH_3 > NH_2^-$.

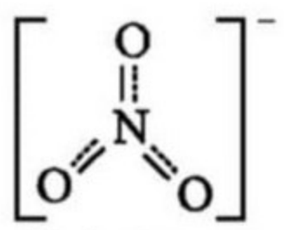
4. (d): P^{5+} has more effective nuclear charge and smaller size than P^{3+}.

5. (a): $[O=N=O]^+$

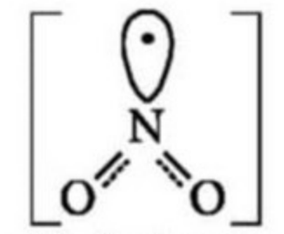
sp hybridisation



sp^2 hybridisation



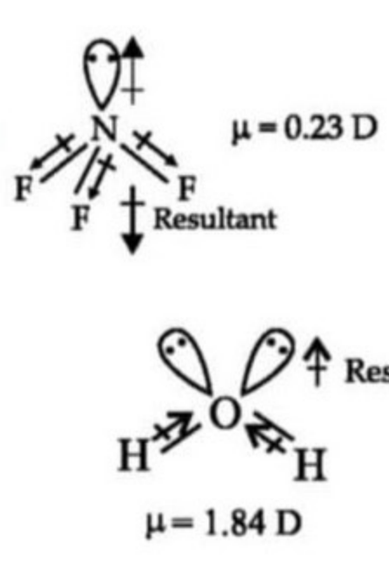
sp^2 hybridisation

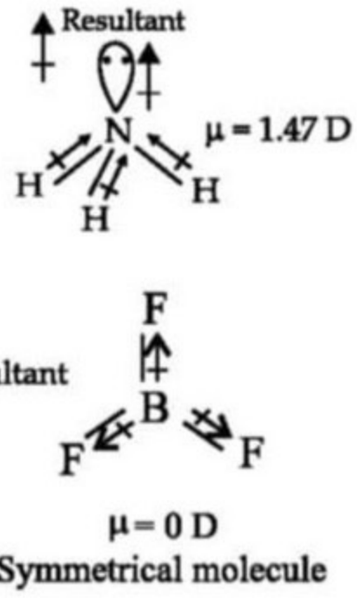


sp^2 hybridisation

6. (d)

7. (b):





8. (a): $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$, $Z = 15$ *i.e.*, phosphorus.

Atomic number of element below it = 15 + 18 = 33 *i.e.*, arsenic.

9. (b)

1. $lp - lp = 0$; $lp - bp = 4$; $bp - bp = 2$
2. $lp - lp = 1$; $lp - bp = 3$; $bp - bp = 2$
3. $lp - lp = 0$; $lp - bp = 6$; $bp - bp = 0$

Structure (1) is most stable because it has minimum *lp-lp* repulsion as compared to (2) and minimum *lp-bp* repulsion as compared to (3).

10. (b):

Ion :	Mn^{2+}	Cu^{2+}	Fe^{2+}	Ni^{2+}
E.C. :	$3d^5$	$3d^9$	$3d^6$	$3d^8$
Number of unpaired electrons :	5	1	4	2

Hence, lowest paramagnetism is shown by $CuSO_4.5H_2O$.

11. (a) : CO is referred as practically non-polar as it possess very small dipole moment because electron drift from C to O is almost nullified by the π-electron drift from O to C.

12. (c) : For alkali metals:

$(I.E.)_1 << (I.E.)_2$

13. (d)

14. (c) : Ionic character is 50% when electronegativity difference is about 1.9 which is for curve (*C*).

15. (b) : $1s^2, 2s^2, 2p^5$ (F)

$1s^2, 2s^2, 2p^6, 3s^2, 3p^5$ (Cl)

$1s^2, 2s^2, 2p^3$ (N)

$1s^2, 2s^2, 2p^6$ (Ne)

Electron affinity : Cl > F > N > Ne

Thus, $\underset{2}{Cl} > \underset{1}{F} > \underset{3}{N} > \underset{4}{Ne}$

16. (c) **17. (a)**

18. (a) : Second ionisation energy is always greater than first ionisation energy.

19. (c) **20. (c)**

21. (b) : Hybridisation $(X) = \frac{1}{2}[VE + MA - c + a]$

(a) $SF_6 \Rightarrow X = \frac{1}{2}[6 + 6 - 0 + 0] = 6 \Rightarrow sp^3d^2$

(b) $PF_5 \Rightarrow X = \frac{1}{2}[5 + 5 - 0 + 0] = 5 \Rightarrow sp^3d$

(c) $[CrF_6]^{3-} \Rightarrow sp^3d^2$ hybridisation

(d) $[BrF_5] \Rightarrow X = \frac{1}{2}[7 + 5 + 0 + 0] = 6 \Rightarrow sp^3d^2$

Hence, PF_5 exhibits sp^3d hybridisation, not sp^3d^2.

22. (a)

23. (d) : O_2^{2-} : $KK, (\sigma 2s)^2, (\sigma^* 2s)^2, (\sigma 2p_z)^2, (\pi 2p_x)^2 = (\pi 2p_y)^2, (\pi^* 2p_x)^2 = (\pi^* 2p_y)^2$

B.O. $= \frac{1}{2}(8 - 6) = 1$

O_2 : $KK, (\sigma 2s)^2, (\sigma^* 2s)^2, (\sigma\, 2p_z)^2, (\pi 2p_x)^2 = (\pi 2p_y)^2, (\pi^* 2p_x)^1 = (\pi^* 2p_y)^1$

B.O. $= \frac{1}{2}(8 - 4) = 2$

Thus, O_2 has stronger bonding than O_2^{2-}.

N_2 : $KK, (\sigma 2s)^2, (\sigma^* 2s)^2, (\pi 2p_x)^2 = (\pi 2p_y)^2, (\sigma 2p_z)^2$

B.O. $= \frac{1}{2}(8 - 2) = 3$

N_2^+ : $KK, (\sigma 2s)^2, (\sigma^* 2s)^2, (\pi 2p_x)^2 = (\pi 2p_y)^2, (\sigma 2p_z)^1$

B.O. $= \frac{1}{2}(7 - 2) = 2.5$

Thus, N_2 has stronger bonding than N_2^+.

NO^+ : $KK, (\sigma 2s)^2, (\sigma^* 2s)^2, (\pi 2p_x)^2 = (\pi 2p_y)^2, (\sigma 2p_z)^2$

B.O. $= \frac{1}{2}(8 - 2) = 3$

NO^- : $KK, (\sigma 2s)^2, (\sigma^* 2s)^2, (\sigma 2p_z)^2, (\pi 2p_x)^2 = (\pi 2p_y)^2, (\pi^* 2p_x)^1 = (\pi^* 2p_y)^1$

B.O. $= \frac{1}{2}(8 - 4) = 2$

Thus, NO^+ has stronger bonding than NO^-.

24. (c) : $N_2O \Rightarrow \overset{-}{N} = \overset{+}{N} = O$

$I_3^- \Rightarrow$ with 2 *bp* and 3 *lp* around central atom is linear.

$N_3^- \Rightarrow$ with 2 *bp* (stereoactive pairs) around the central atom is linear.

25. (a) : The electronic configuration of the element with $Z = 114$ (flerovium) is $[Rn]5f^{14}\, 6d^{10}7s^27p^2$. Hence, it belongs to carbon family which has the same outer electronic configuration.

26. (b) : The energy difference between most stable resonating structure and resonance hybrid structure is known as resonance energy.

Most stable resonating structure will have the minimum energy = E_1

Thus, resonance energy = $E_1 - E_0$.

27. (c) : Energy of the electron in the first orbit of H-atom,

$E_1 = -2.18 \times 10^{-18}$ J

Ionisation energy = $E_\infty - E_n$

Ionisation enthalpy of atomic hydrogen $= (E_\infty - E_1)\, N_A$

$= [0 - (-2.18 \times 10^{-18})] \times 6.023 \times 10^{23}$

$= 2.18 \times 6.023 \times 10^5$ J mol^{-1}

$= 13.13 \times 10^5$ J mol^{-1} $= 1.313 \times 10^6$ J mol^{-1}.

28. (c) : If 2*s*-2*p* mixing is not operative, then molecular orbitals may be arranged in order of energy as follows :

$\sigma 1s, \sigma^* 1s, \sigma 2s, \sigma^* 2s, \sigma 2p_z, \sigma 2p_x = \pi 2p_y, \pi^* 2p_x = \pi^* 2p_y, \sigma^* 2p_z$

Applying this configuration, Be_2, B_2 and N_2 will be diagmagnetic, but C_2 will be paramagnetic.

29. (b)

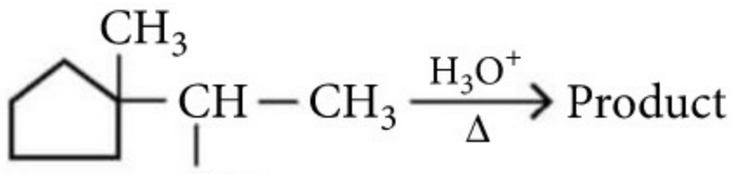
30. (c) : H_2O_2, HCN and conc. CH_3COOH form intermolecular hydrogen bonding while cellulose has intramolecular hydrogen bonding.

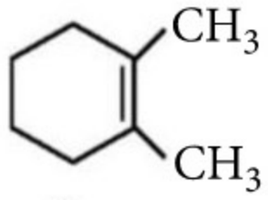
GET SET GO for NEET

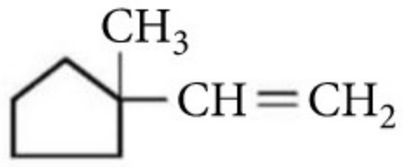
with exclusive and brain storming MCQs

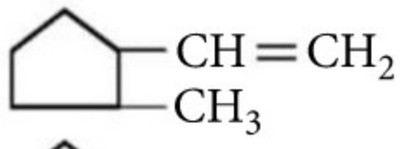
Practicing these MCQs help to strengthen your concepts and give you extra edge in your NEET preparation

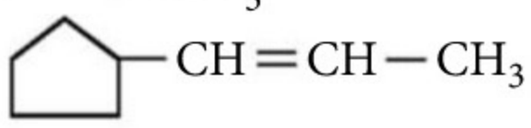
1. The major product of dehydration of the following



(a) 

(b) 

(c) 

(d) 

2. In the absence of Aufbau rule and also assume that each orbital can take maximum of three electrons, then number of elements in different periods are

Period	3	4	5
(a)	18	18	32
(b)	18	32	50
(c)	27	27	48
(d)	27	48	75

3. On being placed in water, sodium peroxide not only produces an alkaline solution but also some bubbles. If we assume that the peroxide ion picks up two protons from water to produce a compound that can be seen as the dibasic conjugate acid of peroxide ion and then this compound undergoes a redox disproportionation.

Using the above information, identify *X* and *Y*.

$Na_2O_{2(s)} + H_2O_{(l)} \longrightarrow X + Y$

(*X*) and (*Y*) are

(a) H_2O and O_2 (b) H_2O_2 and NaOH

(c) NaOH and O_2 (d) Na_2O and NaOH

4. Given the following reactions,

propyne + $HCl_{(g)} \rightarrow A$

$A + HI_{(g)} \rightarrow B$

The compounds *A* and *B* are respectively

(a) 1-chloropropene and 1-chloro-1-iodopropane

(b) 1-chloropropene and 1-chloro-2-iodopropane

(c) 2-chloropropene and 2-chloro-2-iodopropane

(d) 2-chloropropene and 1-iodo-2-chloropropene.

5. Consider the following statements :

(i) A balanced chemical reaction should follow law of conservation of mass on either side.

(ii) 2 moles of $H_{2(g)}$ and 3 moles of $O_{2(g)}$ produce 3 moles of water.

(iii) Equal wt. of carbon and oxygen are taken to produce CO_2, then O_2 is limiting reagent.

The above statements (i), (ii), (iii) respectively are (T = True, F = False)

(a) TTT (b) FTF (c) FFF (d) TFT

6. For the reaction, $CO_{(g)} + \frac{1}{2}O_{2(g)} \longrightarrow CO_{2(g)}$, ΔH, and ΔS are –283 kJ and –87 JK^{-1}, respectively. It was intended to carry out this reaction at 1000, 1500,

3000 and 3500 K. At which of these temperatures would this reaction be thermodynamically spontaneous?
(a) 1500 and 3000 K (b) 1000 and 3500 K
(c) 1000, 1500 and 3000 K (d) 1500, 3000 and 3500 K

7. Sulphur reacts with chlorine 1 : 2 ratio and forms *X*. Hydrolysis of *X* gives a sulphur compound *Y*. What is the hybridisation state of central atom in the compound *Y*?
(a) sp (b) sp^3 (c) sp^2 (d) dsp^2

8. Standard electrode potentials of redox couples A^{2+}/A, B^{2+}/B, C^{2+}/C and D^{2+}/D are 0.3 V, –0.5 V, –0.75 V and 0.9 V respectively. Which of these is best oxidising agent and reducing agent respectively?
(a) D^{2+}/D and B^{2+}/B (b) B^{2+}/B and D^{2+}/D
(c) D^{2+}/D and C^{2+}/C (d) C^{2+}/C and D^{2+}/D.

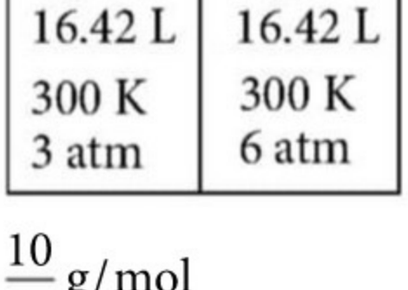
9. Identify the incorrect statement from the following
(a) Ozone absorbs the intense ultraviolet radiation of the sun.
(b) Depletion of ozone layer is because of its chemical reactions with chlorofluoro alkanes.
(c) Ozone absorbs infrared radiation.
(d) Oxides of nitrogen in the atmosphere can cause the depletion of ozone layer.

10. If the partition is removed the average molar mass of the sample will be (Assume ideal behaviour).

H_2	D_2
16.42 L	16.42 L
300 K	300 K
3 atm	6 atm

(a) $\frac{1}{2}$ g/mol (b) $\frac{10}{3}$ g/mol
(c) $\frac{3}{2}$ g/mol (d) $\frac{5}{3}$ g/mol

11. The value of equilibrium constant of a reaction changes with change of temperature and the change is given by van't Hoff equation, $\frac{d\ln K_p}{dT} = \frac{\Delta H^\circ}{RT^2}$, where enthalpy change, ΔH° is taken as constant in the small temperature range.
If for reaction, $A_{(g)} + 3B_{(g)} \rightleftharpoons 2C_{(g)}$, a plot of $\ln K_{eq}$ versus for $1/T$ a reaction is shown, then which of the following condition will be favourable for formation of product *C*?



(a) Low temperature and high pressure
(b) High temperature and high pressure
(c) High temperature and low pressure
(d) Low temperature and low pressure

12. The number of structural and configurational isomers of a bromo compound, C_5H_9Br, formed by the addition of HBr to 2-pentyne respectively are
(a) 2 and 2 (b) 2 and 4
(c) 4 and 2 (d) 2 and 1

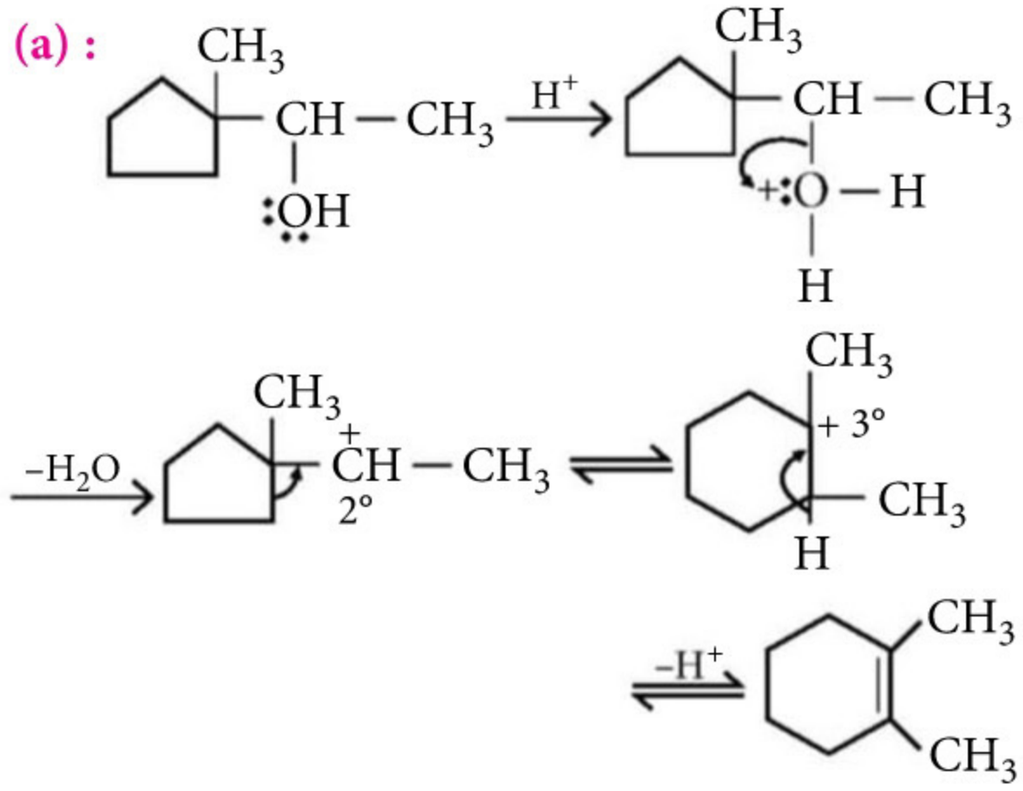
13. Magnetic moments of the following isoelectronic species (24 electrons) are in order Mn^+, Cr, Fe^{2+}, Co^{3+}
(a) $Fe^{2+} = Co^{3+} < Mn^+ = Cr$
(b) $Fe^{2+} = Cr < Co^{3+} = Mn^+$
(c) $Cr < Mn^+ < Fe^{2+} < Co^{3+}$
(d) $Fe^{2+} < Co^{3+} < Mn^+ < Cr$

14. The hydride ion, H^-, is a stronger base than the hydroxide ion, OH^-. Which one of the following reactions will occur if sodium hydride (NaH) is dissolved in water?
(a) $H^-_{(aq)} + H_2O_{(l)} \longrightarrow OH^-_{(aq)} + 2H^+_{(aq)} + 2e^-$
(b) $H^-_{(aq)} + H_2O_{(l)} \longrightarrow OH^-_{(aq)} + H_{2(g)}$
(c) $H^-_{(aq)} + H_2O_{(l)} \longrightarrow H_3O^-_{(aq)}$
(d) $H^-_{(aq)} + H_2O_{(l)} \longrightarrow$ No reaction

15. Beryllium and aluminium exhibit many properties which are similar. But, the two elements differ in
(a) exhibiting maximum covalency in compounds
(b) exhibiting amphoteric nature in their oxides
(c) forming polymeric hydrides
(d) forming covalent halides.

SOLUTIONS

1. (a) :



2. (d) :

Period	Suborbit	Orbitals	Elements	Total
3	3*s*	1	3	
	3*p*	3	9	27
	3*d*	5	15	

4	4*s* 4*p* 4*d* 4*f*	1 3 5 7	3 9 15 21	48
5	5*s* 5*p* 5*d* 5*f* 5*g*	1 3 5 7 9	3 9 15 21 27	75

3. **(c) :** From the given information, we can see that the reaction proceeds via formation of H_2O_2 (which is diabasic conjugate acid of peroxide ion), H_2O_2 then disproportionates into water and oxygen.

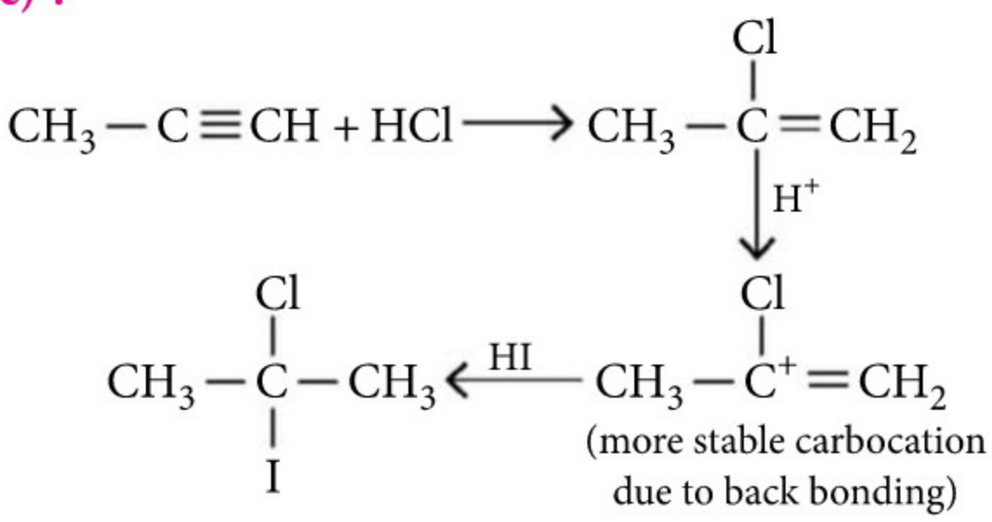
$$Na_2O_{2(s)} + 2H_2O_{(l)} \longrightarrow 2NaOH_{(aq)} + H_2O_{2(aq)}$$

$$H_2O_{2(aq)} \longrightarrow H_2O_{(l)} + \frac{1}{2}O_{2(g)}$$

Thus, overall reaction is

$$Na_2O_{2(s)} + H_2O_{(l)} \longrightarrow 2NaOH_{(aq)} + \frac{1}{2}O_{2(g)}$$

4. **(c) :**



5. **(d) :**

	$2H_2$	+ O_2	$\longrightarrow$	$2H_2O$
Initial mole	2	3		0
Final mole	0	3 – 1 = 2		2

$$C + O_2 \longrightarrow CO_2$$

$$\frac{w}{12} \quad \frac{w}{32}$$

Here, O_2 is limiting reagent.

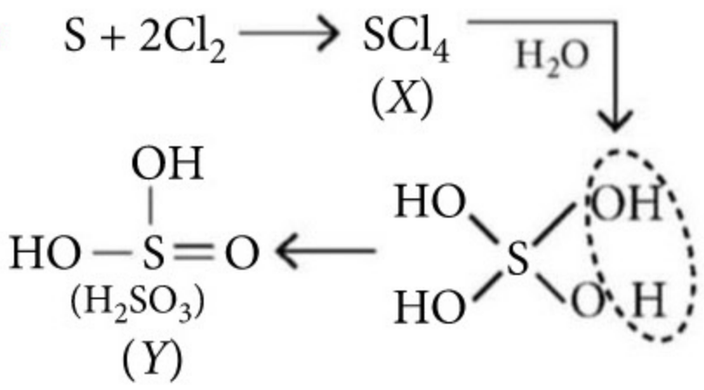
6. **(c) :** $\because \Delta G = \Delta H - T\Delta S$

For a spontaneous reaction ΔG should be negative

$\Delta H = -283$ kJ, $\Delta S = -87$ J K^{-1}

Hence, reaction will be spontaneous when $\Delta H > T\Delta S$. Therefore, at 1000, 1500 and 3000 K the reaction would be spontaneous.

7. **(b) :**



Hybridisation of $H_2SO_3 = \frac{1}{2}(6 + 2 + 0) = 4\ (sp^3)$

8. **(c) :** The redox couple with maximum reduction potential will be best oxidising agent and with minimum reduction potential will be best reducing agent.

9. **(c)**

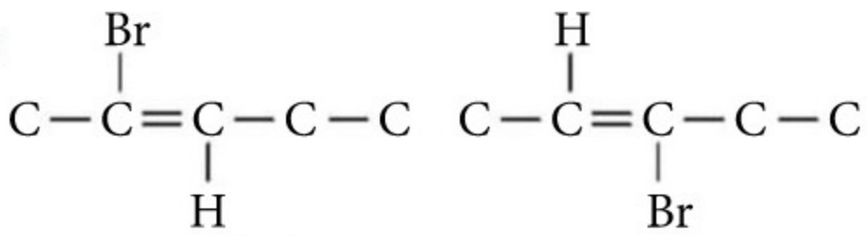
10. **(b) :** Moles of $H_2 = \frac{3 \times 16.42}{0.0821 \times 300} = 2$

Moles of $D_2 = \frac{6 \times 16.42}{0.0821 \times 300} = 4$

Average molecular weight $= \frac{2 \times 2 + 4 \times 4}{4 + 2} = \frac{10}{3}$

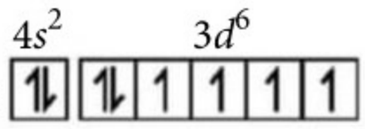
11. **(b) :** Since slope is negative hence reaction is endothermic. So high temperature favours forward reaction similarly high pressure favours forward reaction.

12. **(b) :**

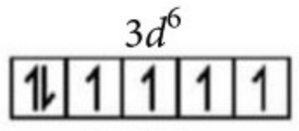


Hence, 2 structural and 4 geometrical isomers.

13. **(a) :** Fe(26) : $[Ar]4s^2 3d^6$:

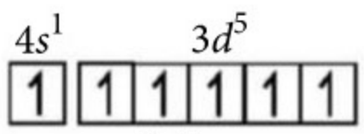


$Fe^{2+}(24) : [Ar]4s^0 3d^6$:



unpaired electrons, $n = 4$

$Cr(24) : [Ar]4s^1 4d^5$:



unpaired electrons, $n = 6$

$Mn(25) : [Ar]\ 4s^2 3d^5$

$Mn^+(24) : n = 6$

$Co(27) : [Ar]4s^2 3d^7$

$Co^{3+}(24) : n = 4$

Magnetic moment $= \sqrt{n(n+2)}$ BM

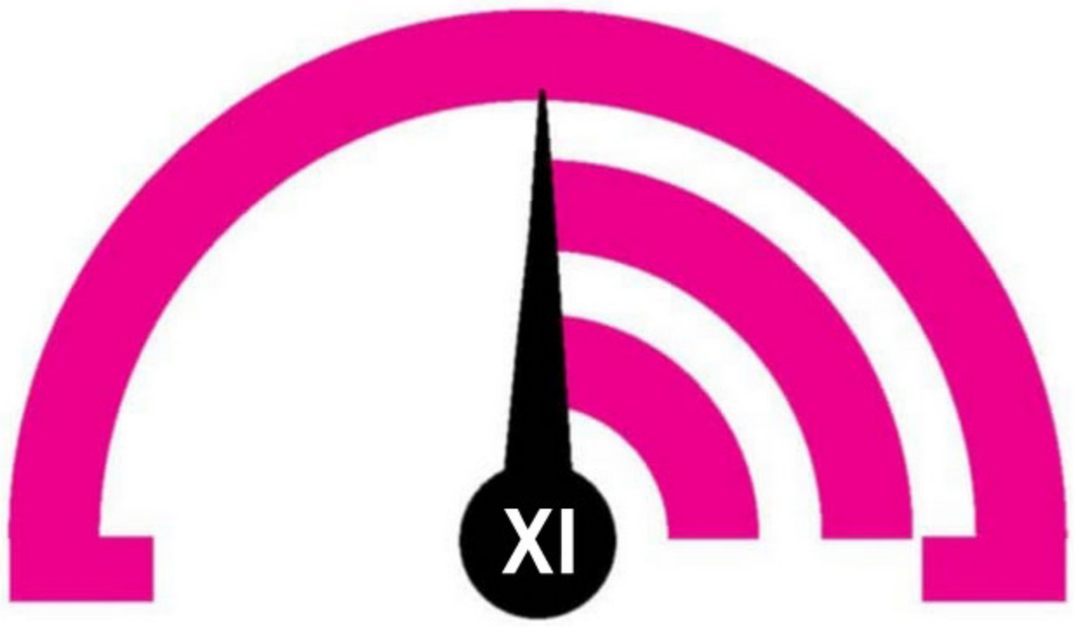
Thus, $Fe^{2+} = Co^{3+} < Mn^+ = Cr$

14. **(b) :** $\underset{\text{base 1}}{H^-_{(aq)}} + \underset{\text{acid 1}}{H_2O_{(l)}} \longrightarrow \underset{\text{base 2}}{OH^-_{(aq)}} + \underset{\text{acid 2}}{H_{2(g)}}$

In this reaction H^- acts as Bronsted base as it accepts one proton (H^+) from H_2O and form H_2.

15. **(a) :** The maximum valency of beryllium is +2 while that of aluminium is +3.

MONTHLY TEST DRIVE



This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120

Hydrocarbons and Environmental Chemistry

Time Taken : 60 Min.

NEET

Only One Option Correct Type

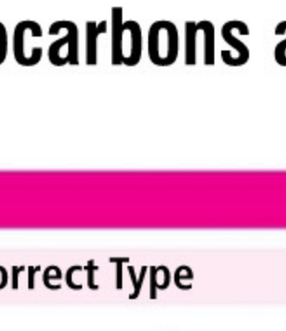
1. Which of the following causes damage to the building containing calcium carbonate and responsible for cough and choking in humans?

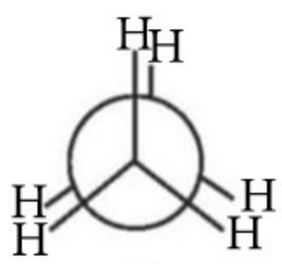
(a) Sulphur (b) Carbon

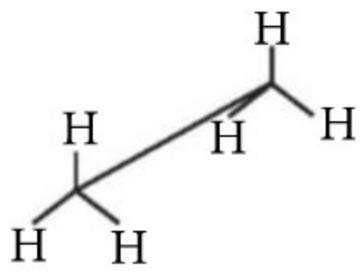
(c) Nitrogen (d) Sulphur dioxide

2. In the following structures which two forms are the staggered conformation of ethane?


(1)


(2)


(3)


(4)

(a) 1 and 4 (b) 2 and 3

(c) 1 and 2 (d) 1 and 3

3. Which of the following alkene will give same product when treated with HBr in presence and absence of benzoyl peroxide?

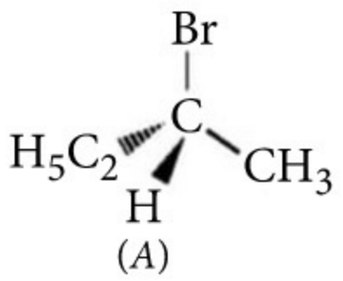
(a) 1, 1-Dichloroethene

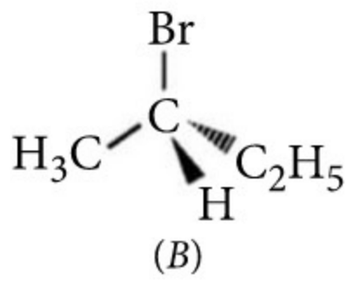
(b) *trans*-1,2-Dichloro-2-pentene

(c) *cis*-1,2-Dichloro-2-pentene

(d) 2-Butene

4. Addition of HBr to 1-butene gives a mixture of products *A*, *B* and *C*.


(*A*)


(*B*)

$CH_3CH_2CH_2CH_2—Br$

(*C*)

The mixture consists of

(a) *A* and *B* as major and *C* as minor product

(b) *B* as major, *A* and *C* as minor products

(c) *B* as minor, *A* and *C* as major products

(d) *A* and *B* as minor and *C* as major product.

5. How carbon monoxide emitted by automobiles prevents transport of oxygen in the body tissues?

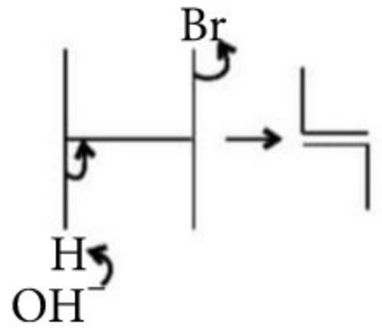
(a) By changing oxygen into carbon dioxide.

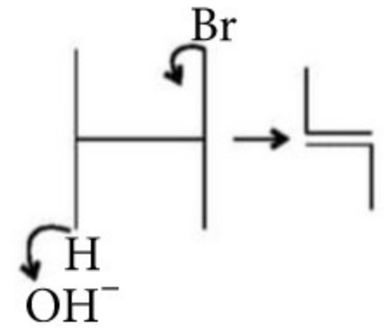
(b) By destroying the haemoglobin.

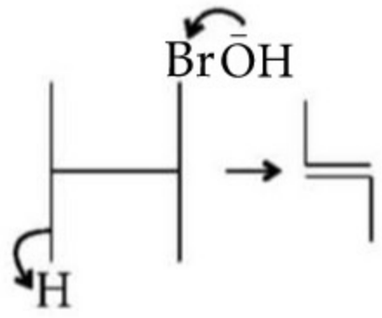
(c) By forming a stable compound with haemoglobin.

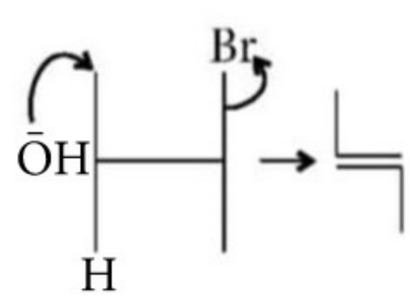
(d) By obstructing the reaction of oxygen with haemoglobin.

6. Dehydrohalogenation in presence of OH^- is correctly represented by

(a) 

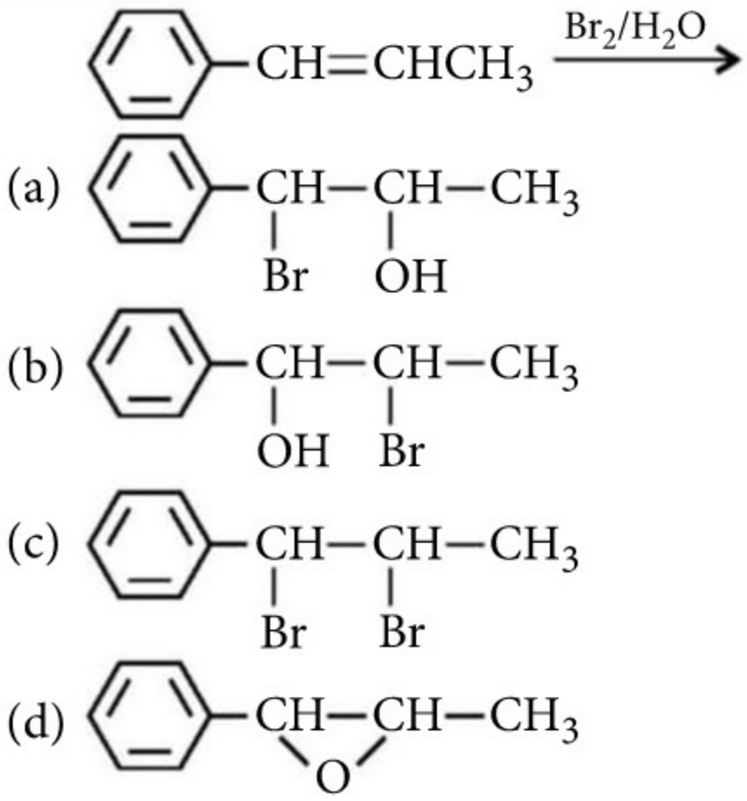
(b) 

(c) 

(d) 

7. Which of the following statement is false?
   (a) London smog is oxidising in nature.
   (b) London smog contains H_2SO_4 droplets.
   (c) London smog is formed in winter.
   (d) London smog causes bronchitis.

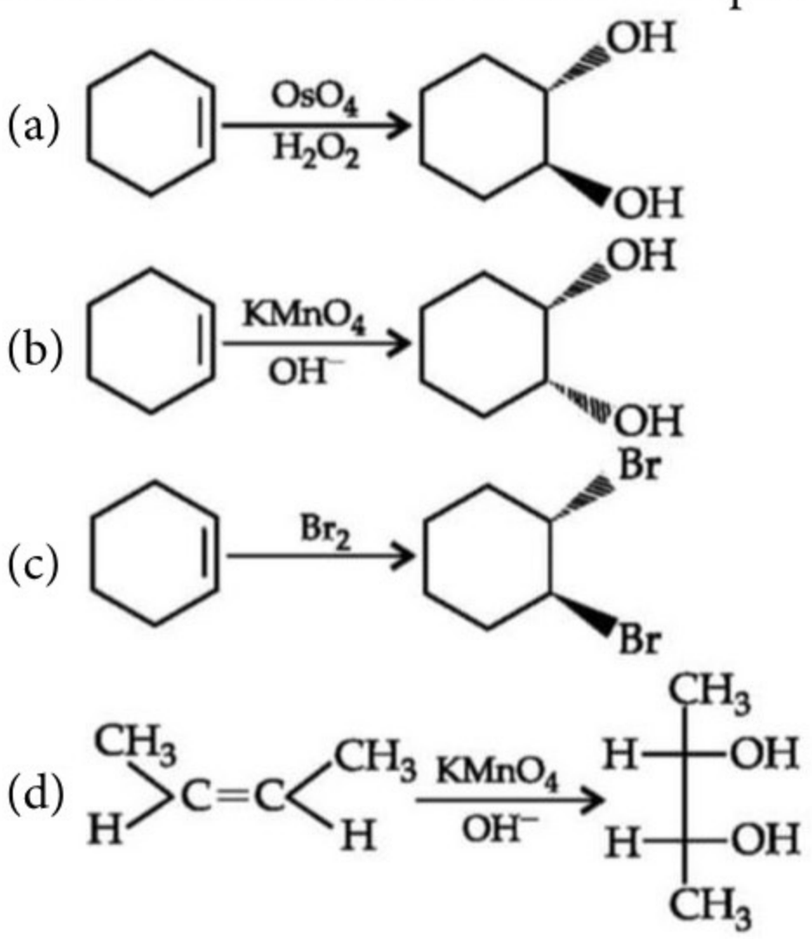
8. Identify the major product of the following reaction.



9. Growth of fish is not as healthy in warm water as in cold water because
   (a) the amount of D.O. in warm water is higher than in cold water
   (b) warm water is not liked by fish
   (c) cold water contains more marine plants
   (d) the amount of D.O. in warm water is less than in cold water.

10. Brewery and sugar factory waste alters the quality of a water body by increasing
   (a) temperature (b) turbidity
   (c) pH (d) COD and BOD.

11. In the given reactions, identify the one where wrong stereoisomer has been shown as the product.



12. Which of the following statements about polar stratospheric clouds (PSCs) is not correct?
   (a) Type I clouds are formed at about –77°C and contain solid $HNO_3 \cdot 3H_2O$.
   (b) Type II clouds are formed at about –85°C and contain some ice.
   (c) A tight whirlpool of wind called Polar Vortex is formed which surrounds Antarctica.
   (d) PSCs do not react with chlorine nitrate and HCl.

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. **Assertion :** Melting of glaciers and polar ice caps would result into the rise in level of sea water thus flooding the coastal lands.
Reason : Greenhouse effect is responsible for global warming.

14. **Assertion :** Friedel-Crafts reaction between benzene and acetic anhydride in the presence of anhydrous $AlCl_3$ yields acetophenone and not poly substituted products.
Reason : Acetophenone formed poisons the catalyst preventing further reaction.

15. **Assertion :** Water pollutants are measured by BOD.
Reason : If BOD is more, the water is polluted.

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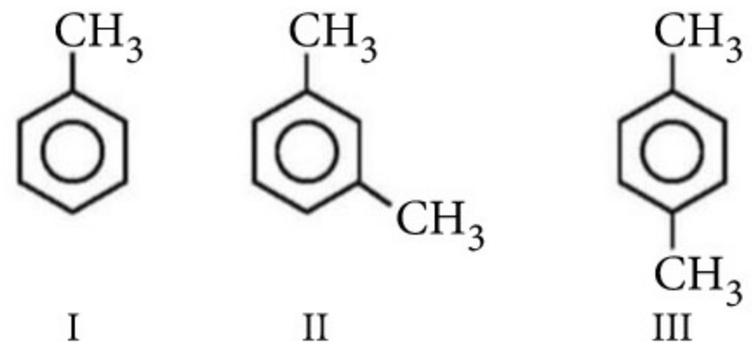
Only One Option Correct Type

16. The ease of nitration of the following three hydrocarbons follows the order



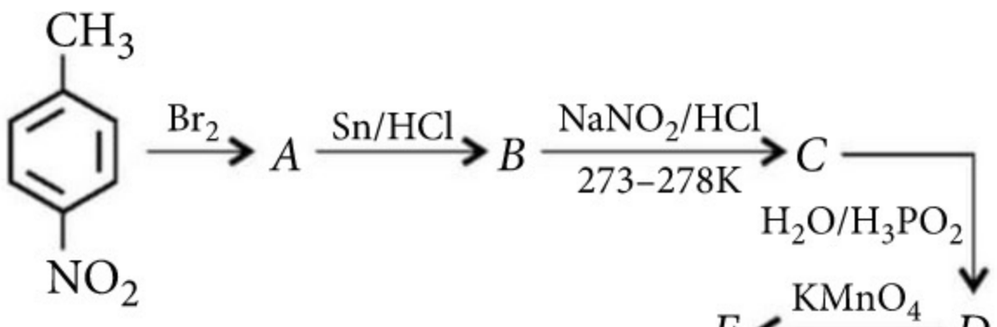
I II III

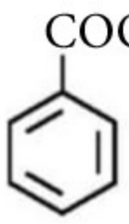
(a) II = III ≈ I (b) II > III > I
(c) III > II > I (d) I = III > I

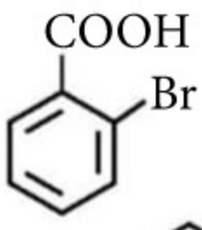
17. Which of the following pollutants effect more to organisms of the higher trophic level of a food chain due to biological amplification?

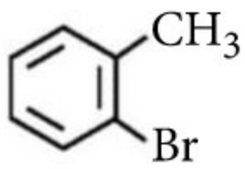
(a) Sewage and plant fertilisers
(b) Detergents
(c) Heavy metals mercury salts and non-biodegradable phenolic chemicals
(d) Poisonous cyanides

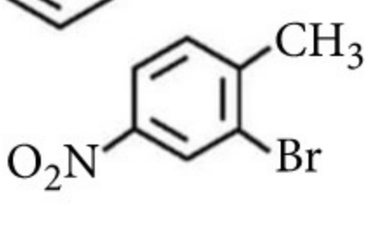
18. Identify the product (*E*) in the following sequence of reactions?



(a) 

(b) 

(c) 

(d) 

19. Which of the following is not an example of green chemistry?

(a) Catalytic dehydrogenation of diethanolamine without using cyanide and formaldehyde.
(b) Replacement of CFCs by CO_2 as blowing agent in the manufacture of polystyrene foam sheets.
(c) Reacting methylamine and phosgene to produce methyl isocyanate.
(d) Replacement of organotins by 'sea-nine' as anti fouling compound in sea marines.

More than One Options Correct Type

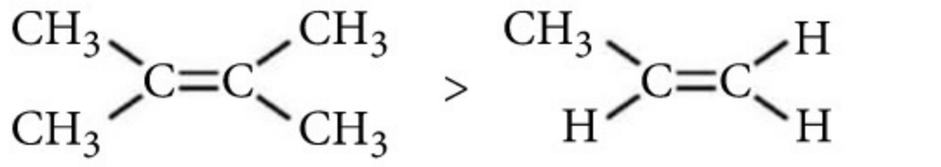
20. Which of the following are aromatic?

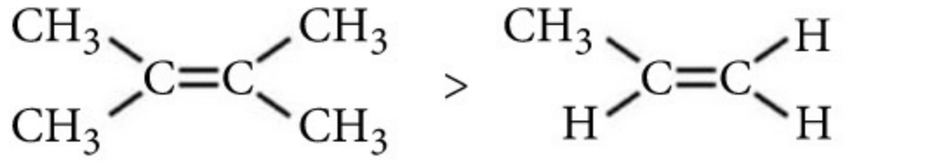
(a) Cyclopentadienyl cation
(b) Cyclopropenyl cation
(c) Tropylium cation
(d) Cyclopentadienyl anion

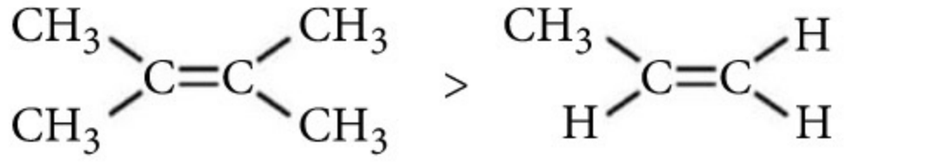
21. Which of the following statements pertaining to pollutants are incorrect?

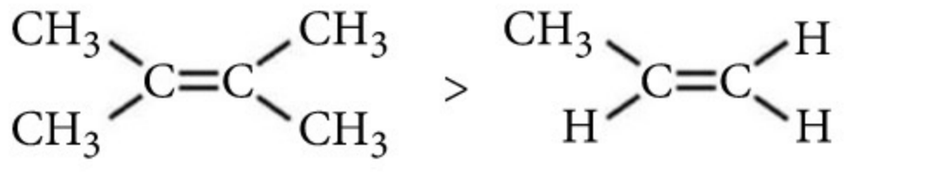
(a) DDT is a non-biodegradable pollutant.
(b) Excess fluoride in drinking water causes osteoporosis.
(c) Excess cadmium in drinking water causes black foot disease.
(d) Methyl mercury in water may cause "Itai-Itai disease".

22. Pick the correct order(s).

(a)  (stability)

(b)  (reactivity towards HBr addition)

(c)  (reactivity towards catalytic hydrogenation)

(d)  (reactivity towards hydroboration)

23. Pick up the incorrect statements?

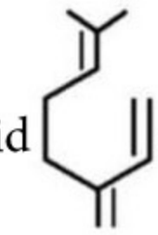
(a) CO which is a major pollutant resulting from the combustion of fuels in automobiles plays a major role in photochemical smog.
(b) Classical smog has an oxidising character while the photochemical smog is reducing in character.
(c) Photochemical smog occurs in day time whereas the classical smog occurs in winters in early morning hours.
(d) During formation of smog the level of ozone in the atmosphere goes down.

Numerical Value Type

24. $CH_3-C\equiv CH \xrightarrow[2.\ D_3O^+]{1.\ NaNH_2} A \xrightarrow[Pd\text{-}BaSO_4]{D_2} B$

Total number of deuterium atoms in the final product is

25. Number of oxygen atoms in peroxyacetylnitrates (PAN) is

26. The number of products formed by reductive ozonolysis of myrcene, a terpenoid  is

Comprehension Type

An ethereal solution of an alkyl halide (preferably the bromide or iodide) is treated with sodium

$2R{-}X + 2Na \xrightarrow{Ether} R{-}R + 2NaX$

$2CH_3{-}Br + 2Na \xrightarrow{Ether} CH_3{-}CH_3 + 2NaBr$

$CH_3CH_2Br + 2Na + CH_3Br \xrightarrow{Ether} CH_3CH_2{-}CH_3 + 2NaBr$

In this reaction, product has new (C—C) bond. With same type of alkyl halide, product has symmetry, this helps in deciding the nature of reacting alkyl halide. Intermediates are free radicals (carbenes).

27. CH_3CH_2Br undergoes Wurtz reaction. We may expect some of the following products :

$A : CH_3CH_2CH_2CH_3$ $B : CH_2{=}CH_2$

$C : CH_3{-}CH_3$

Select the correct option.

(a) only A (b) A and B

(c) A, B and C (d) A and C

28. $CH_3CH_2CH_2CH_3 \xrightarrow[h\nu \text{ controlled}]{Cl_2} \xrightarrow{Na/ether}$

Major product of the above reaction is

(a) $CH_3(CH_2)_6CH_3$

(b) $CH_3CH_2\underset{\displaystyle CH_3}{\underset{|}{C}}H{-}\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_2CH_3$

(c) $CH_3\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_2CH_2\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_3$

(d) none of the above.

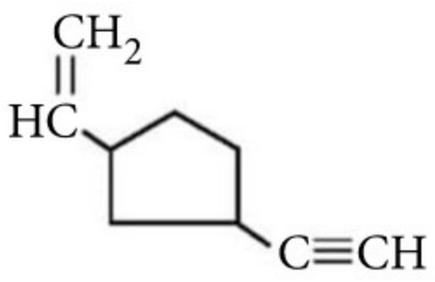
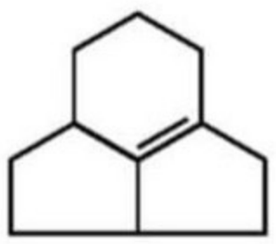
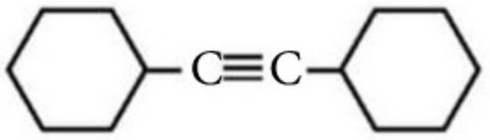
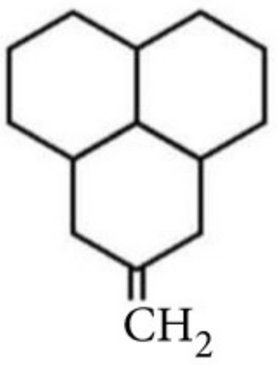
Matrix Match Type

29. Match the entries listed in column I with appropriate entries listed in column II.

Column I (Region)	Column II (Component)
(A) Troposphere	(P) e^-
(B) Ozonosphere	(Q) O_2^+
(C) Mesosphere	(R) N_2
(D) Thermosphere	(S) O_2

	A	B	C	D
(a)	P, Q	R, S	P, Q, R	R
(b)	R	Q, R	Q, R, S	P, Q
(c)	R, S	R, S	R, S	P, Q
(d)	R, S	R, S	Q, R, S	P, Q

30. Match the entries listed in column I with appropriate entries listed in column II.

Column I	Column II
(A) 	(P) Gives +ve test with $AgNO_3/NH_4OH$
(B) 	(Q) With hot alkaline $KMnO_4$ gives dicarboxylic acid.
(C) 	(R) With O_3 followed by H_2O_2/CH_3COOH cannot give diacid.
(D) 	(S) Gives CO_2 on oxidation using hot alkaline $KMnO_4$.

	A	B	C	D
(a)	P, Q, R	R, S	P	Q
(b)	P, Q, S	R	R	R, S
(c)	P, S	Q, R	P	Q, S
(d)	P, Q, S	Q, R	S	P, Q

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